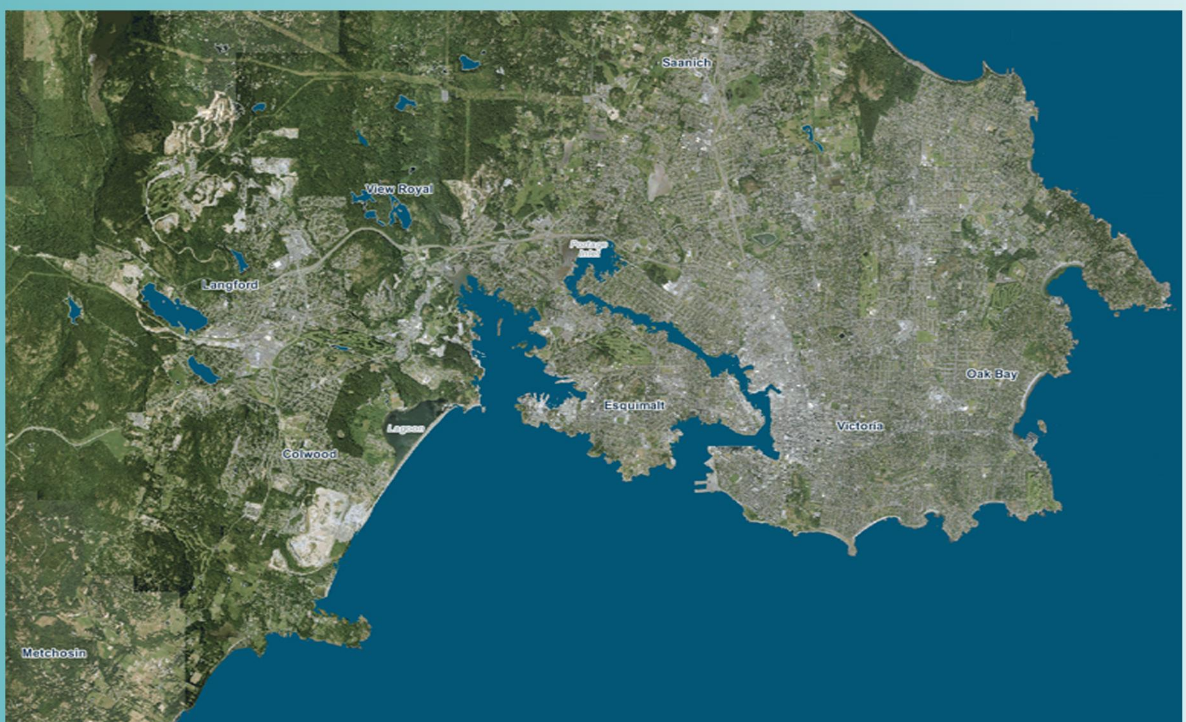
Capital Regional District

Core Area Wastewater Treatment Program
Watewater Treatment Plant
Option 1A



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December 08, 2009

Capital Regional District

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Wastewater Treatment Plant
Option 1A

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Executive Summary

E.1 Background

The CRD is currently in the process of planning wastewater treatment facilities for the Core Area of Greater Victoria. The BC Ministry of Environment has mandated that secondary treatment be in place by the end of 2016. Decentralized treatment facilities have been identified to serve the major sanitary sewer catchments within Greater Victoria. Three program options: Option 1A, 1B and 1C were assessed by the consulting team. Following detailed assessments, Option 1A has been selected as the preferred strategy for implementation by the CRD. **Table E.1** describes the major facilities which are part of Option 1A.

Table E.1
Major Facilities to be Constructed Under Option 1 A

Location	Description of Facility
Saanich East - North Oak Bay WWTP	New secondary liquid train treatment plant, new outfall parallel to existing outfall, collection system modifications, influent pumping station, solids discharged to collection system for downstream treatment.
Clover Point WWTP	Wet weather treatment for 2 - 4 x ADWF, pump station and forcemain to McLoughlin Point to transfer flows up to 2 X ADWF for secondary treatment. Screening for all flows above 4 X ADWF. Wet weather treatment plant could be deferred or eliminated pending discussions with Provincial and Federal regulators.
McLoughlin Point WWTP	Secondary treatment plant to treat flows from Macaulay and Clover catchments up to 2 x ADWF. Primary treatment for all flows up to 4 X ADWF. Pump station at Macaulay to convey flows to McLoughlin for treatment.
Hartland Landfill Biosolids Treatment	Regional biosolids treatment facility to treat biosolids from the McLoughlin Point plant and West Shore plant.
Macaulay Point	Pump Station to convey flows to McLoughlin Point. Macaulay wet weather flows are treated at McLoughlin. Screening for all flows above 4 x ADWF.
West Shore Plant	New Secondary Liquid Train Treatment Plant serving only West Shore communities.
Conveyance Facilities	Forcemain to transfer flows from Clover Point to McLoughlin. Tunnel or forcemain to transfer flows to McLoughlin.
Outfalls	New Outfalls at Saanich East - North Oak Bay, Macaulay and West Shore.
Resource Recovery	Resource recovery includes effluent heat recovery, biomethane recovery and production of soil amendment and fuel for cement kilns.

E.2 Facility Siting

Potential sites for new facilities are currently being investigated and are summarized in **Table E.2**.

Table E.2
Current Siting Opportunities for Treatment Facilities

Location	Potential Facilities	Comments
Saanich East - North Oak Bay	Secondary Treatment Plant	Three potential sites identified and under discussion. Finnerty Arbutus site owned by CRD and is preferred site.
Clover Point	Wet weather treatment and pumping	Existing site with limited available space, but sufficient space for wet weather plant. Discussing elimination of plant because of infrequency of overflows.
McLoughlin Point	Secondary Treatment Plant	New site which would require purchase and remediation. Risk associated with remediation and schedule impacts. One of the only available sites which could be purchased in the Core Area. Site is constrained with no room for digestion or expansion. Rock excavation and difficult construction conditions anticipated.
Macaulay Point	Pumping station and forcemains to McLoughlin	Existing site with limited available space. Adjacent land owned by DND.
Hartland Landfill	Biosolids Treatment and Processing Facility	Pipeline and pumping stations required to transfer sludge flows from McLoughlin Point WWTP to Hartland.
West Shore TBD	West Shore plant under Option 1A	Discharge biosolids to downstream Trunk sewer.

E.3 Design Criteria for New Facilities

The new treatment facilities must be designed to satisfy the BC Provincial Municipal Sewage Regulation (MSR) and the proposed Federal National Performance Standards (CCME). The National Performance Standards which were recently announced require secondary treatment plants to meet a performance requirement of $cBOD_5$ of 25 mg/L and a TSS of 25 mg/L based on a monthly average of at least five samples per week. These standards are similar to the BC Provincial not to exceed standards of 45 mg/L $cBOD_5$ and 45 mg/L TSS for discharge to marine waters.

For flows in excess of two times average dry weather flow (ADWF) the BC MSR requires primary treatment capable of providing 130 mg/L TSS and 130 mg/L $cBOD_5$. For CRD, flows from 2-4 times ADWF will be provided with primary treatment.

It is not anticipated that facilities will have to be designed for ammonia nitrogen limits for discharge to marine waters.

Compounds of emerging concern (COECs) are a controversial topic in wastewater treatment design. COECs include microconstituents such as endocrine disrupting compounds, pharmaceutically active compounds (PhACs) and personal care products (PCPs). There is still much to be learned about COECs and their impacts on the environment and public health. Research is ongoing. However, it is prudent to plan for wastewater treatment facilities to include the capability for future process modifications for removal of these constituents should it become a requirement in the future.

E.4 Liquid Train Treatment Design for Options 1A

To enable preparation of cost estimates and assessment of siting options, representative technologies have been selected for evaluation of sites. The final technology selection will be made at the preliminary design phase and may be reconsidered depending on the procurement strategy implemented. This assessment uses proven technologies which have a track record of performance at the scale required for the CRD facilities. The technologies selected will meet the effluent quality discharge objectives and have been successfully used at many installations in North America and Europe.

When undertaking a major wastewater treatment program such as the CRD project, the owner and engineers often receive submissions by numerous technology suppliers who make many claims with respect to new and novel process performance, footprint, and lower costs. Some of these technologies may show promise, but most lack a track record at the scale of facilities required for CRD. The ability of novel technologies to satisfy discharge requirements at reasonable operating costs is often uncertain. If the CRD wants to consider some of these technologies, a thorough independent evaluation should be completed to confirm supplier's claims.

For the current plan, the following representative liquid treatment technologies have been considered:

- Lamella plate primary clarifiers to provide low footprint primary treatment.
- Biological Aerated Filters for McLoughlin Point secondary plant.
- MBR for locations where a small footprint is desired and a high potential for water reuse exists such as the Saanich East - North Oak Bay.
- Conventional Activated Sludge (CAS) for the West Shore plant.

- For wet weather treatment facilities with limited site availability a low footprint technology known as ballasted flocculation (Actiflo) has been selected for assessment purposes.

E.5 Biosolids Design for Option 1A

The biosolids treatment train presents significant opportunities for resource recovery. The biosolids treatment technology will include thermophillic anaerobic digestion capable of producing a Class A biosolid, biosolids drying, recovery of biomethane to produce pipeline quality gas, struvite recovery and production of soil amendment product for reuse. In addition, the biosolids facilities are designed to accept (co-digest) organic food wastes and fats, oils and greases (FOG) to enhance the production of biomethane gas by as much as 50%. The biosolids will be dried and used as a fuel at cement kilns.

A Regional Biosolids Energy Centre will be a key component of the biosolids management plan for the CRD. This energy centre will integrate biosolids and organic wastes and could have a future waste to energy facility as part of the centre to accept solid wastes and biosolids as potential fuel sources.

Ideally the biosolids and liquid waste treatment facilities should be located at a common site. This is not possible under Option 1A, because the McLoughlin site is too small to accommodate the biosolids treatment facilities. If additional land near McLoughlin can be obtained it would be possible to co-locate on the same site.

For this plan biosolids facilities will be located at the CRD operated Hartland landfill. This site would involve construction of four pumping stations and a 17.7 km pipeline to transfer sludge to a biosolids treatment facility at Hartland landfill. This location would provide good synergies for acceptance of FOG and the organic portion of food wastes to enhance digester gas production. In the future waste to energy facilities could be used as an add-on process for integrated biosolids and solid waste processing.

E.6 Conveyance & Pumping

Conveyance and pumping upgrades are required for Option 1A. Under Option 1A, wastewater will be conveyed from the Macaulay and Clover Point outfalls by pumping through new forcemains to the Mc Loughlin Point plant.

Pumping stations and a forcemain are also required for sludge transfer to the biosolids treatment facilities located at Hartland landfill.

New outfalls are required as part of this program. The Saanich East - North Oak Bay plant will require a new outfall parallel to the Finnerty Cove outfall. For Option 1A, the Macaulay outfall must be upgraded to handle design flows from the McLoughlin Plant. The West Shore plant will require a dedicated outfall.

E.7 Resources from Wastewater

Potential opportunities for recovery of resources from wastewater are being investigated. Opportunities for resource recovery include:

POTENTIAL RESOURCE RECOVERY FROM WASTEWATER

- Effluent Reuse for Irrigation
- Effluent Reuse for Toilet Flushing
- Heat Extraction Plant Use in buildings and digester heating
- Heat Extraction for District Heating
- Biomethane Generation
- Dried Sludge Fuel for cement kilns or waste to energy facility
- Phosphorus Recovery (Struvite)

Opportunities for heat recovery and biomethane from the biosolids train are significant. The market for these resources should be explored further as the project progresses and additional market research is conducted.

E.8 Carbon Footprint

A greenhouse gas (GHG) assessment has been completed for the selected option. In wastewater treatment the relevant GHGs include carbon dioxide, methane and nitrous oxide. The direct and indirect emissions and offsets of the GHGs associated with the proposed project have been investigated for the initial construction phase and ongoing operations. Carbon footprint analysis indicates that all options have the potential of being carbon positive depending on the degree of resource recovery implemented. Saleable heat for district heating and biomethane gas sales provide the largest offsets to make the project a carbon positive facility.

E.9 Opinion of Probable Costs

The capital and life cycle costs have been developed for each option and are summarized as below:

Table E.3
Capital Costs

Capital Costs	Option 1A
Total Capital Costs	$967,531,000

Operations and Maintenance Costs for each option are shown in **Table E.4**.

Table E.4
Annual O&M Costs

	Option 1A
Annual O&M Costs	$19,080,000

Life cycle costs for each option are provided in **Table E.5**.

Table E.5
Life Cycle Costs

Costs	Option 1A
Life Cycle Costs	$1,332,141,000

Life cycle costs have been calculated assuming a 25 year period and a discount rate of 6%.

E.10 Risk Assessment

A preliminary risk assessment has been completed for the selected option. Preliminary evaluation indicates that option 1 A has the highest risk associated with unknown impacts of site remediation at the McLoughlin site. Remediation of the site could impact schedule and cost. In terms of siting, Option 1A is the most advanced in terms of the acceptance of plant siting and availability of lands for plant construction.

Risk mitigation strategies can be selected to reduce risks. These strategies will be assessed as the project proceeds and more detailed information becomes available.

E.11 Discussion of Analysis and Recommendation

Option 1A, with the main secondary plant at McLoughlin Point is a viable option because of its proximity to the Macaulay and Clover Point outfalls and the fact that the site is available for purchase. The McLouglin site is contaminated and will require remediation. This presents some risk in terms of overall project schedule as the remediation process could take several years. It is likely that much of the contaminated rock would be removed during plant construction as deep tanks will be constructed. The site is not large enough to accommodate the liquid and biosolids treatment facilities so a separate biosolids processing facility will be constructed at Hartland landfill.

Under Option 1A a separate site at Hartland will be required for biosolids facilities. Biosolids transport between McLoughlin and the Hartland biosolids processing site will be by pipeline which could be routed past downtown areas. Hot water heating and effluent reuse pipelines could be constructed in the same trench and will provide immediate opportunity for district heating and reuse of water in government, commercial and residential buildings.

Under Option 1A initial investigation indicates that the Macaulay wet weather facilities can be incorporated into the McLoughlin Point plant. The footprint of the Clover Point wet weather treatment facility is compact and can be accommodated adjacent to the Clover Point pump station. Because of the infrequency of use it is recommended the CRD continue negotiations with MOE for deferment or elimination of the Clover Point plant. Funds may be better spent on reducing long term infiltration and inflow. However for this plan and budgeting it has been assumed that wet weather treatment facilities at Clover Point are required.

Based on the above considerations, the project team recommends the following:

1. Continue with the Business Case and grant application for the preferred Option 1A.
2. Proceed with further technical development and public consultation for all major facilities.
3. Continue to discuss the deferment or elimination of the Clover Point wet weather plant with the Provincial Ministry of Environment.

Section 1 Introduction

1.1 Background

The Capital Regional District (CRD) is planning the construction of secondary wastewater treatment plants to serve the Core Area of Greater Victoria. This project, known as the Core Area Wastewater Treatment Program (CAWTP), has been in the planning stages for several years. A number of options from decentralized multi-plant treatment to regional wastewater treatment plant schemes have been investigated. Resource recovery has also been investigated. A significant amount of work was completed on assessing three options, referred to as Options 1, 2 and 3 in previous work. These options varied in terms of the number of plants (4 for Option1, 7 for Option 2, and 11 for Option 3) and the degree of resource recovery.

A Peer Review Team was engaged by CRD to review Options 1, 2 and 3 identified three sub–options of Option 1 for further consideration by CRD. Options 2 and 3 were eliminated as they were significantly more costly. The Core Area Liquid Waste Management Committee (CALWMC) requested that the three options put forward by the Peer Review Team, referred to as Option 1A, 1B and 1 C, be investigated further to refine the economic, social and environmental considerations to enable decision making through a triple bottom line (TBL) analysis. Option 1A was subsequently selected as the preferred option by the CRD CALWMC.

The Ministry of Environment has requested that secondary treatment be in place by the end of 2016 and the CRD submit their Liquid Waste Management Plan Amendment by the end of 2009. More recently (August 2009) the Federal Minister of the Environment has announced stricter wastewater treatment regulations which will require all communities to have wastewater treatment. To facilitate this schedule, the preferred wastewater treatment strategy must commence implementation in the near future.

This report presents the proposed wastewater treatment plan to serve the Core Area of the Capital Regional District.

1.2 Previous Work and Reference Materials

During the preparation of this report various technical and background material were reviewed to obtain insight into the previous work. A significant amount of good work has been completed previously by other consultants, CRD staff and the Peer Review Team. This past work forms a building block for a more detailed assessment of the options to be investigated in this report. Most of the reference documents from previous consulting work can be found on CRD web site.

The September 16, 2009 *"Core Area Wastewater Treatment Assessment of Wastewater Treatment options 1A, 1B and 1C"* provides background on the evaluation of the three primary options.

Reference reports and data from previous studies were used and augmented with more detailed assessments by the current study team.

1.3 Findings of the Peer Review Report

In early 2009 the CRD engaged the services of a Peer Review Team (PRT) consisting of North American wastewater treatment experts to review the work that had been completed by the previous planning consultants. The Peer Review Team outlined twelve guiding principles in their assessment of the wastewater treatment options for the CAWTP. These principles are provided below for reference purposes:

- Meet current and future regulatory requirements.
- Maximize potential opportunities for Integrated Resource Recovery.
- Strive for sustainability.
- Maintain greater flexibility for future options.
- Develop facilities that minimize construction and operating costs.
- Maximize wastewater and sludge management opportunities.
- Avoid sites that are difficult to permit.
- Strive to eliminate intermittently operated wet weather plants.
- Evaluate programs and projects using Triple Bottom Line analysis.
- Maximize benefit to the rate payer.

All of these guiding principles are good considerations and will serve as a basis for continued evaluation of the Wastewater Treatment Plan under consideration by the CRD. The current consulting team has reviewed the PRT comments and incorporated many of these suggestions where appropriate.

1.4 CRD Goals and Objective for the Core Area Wastewater Treatment Program

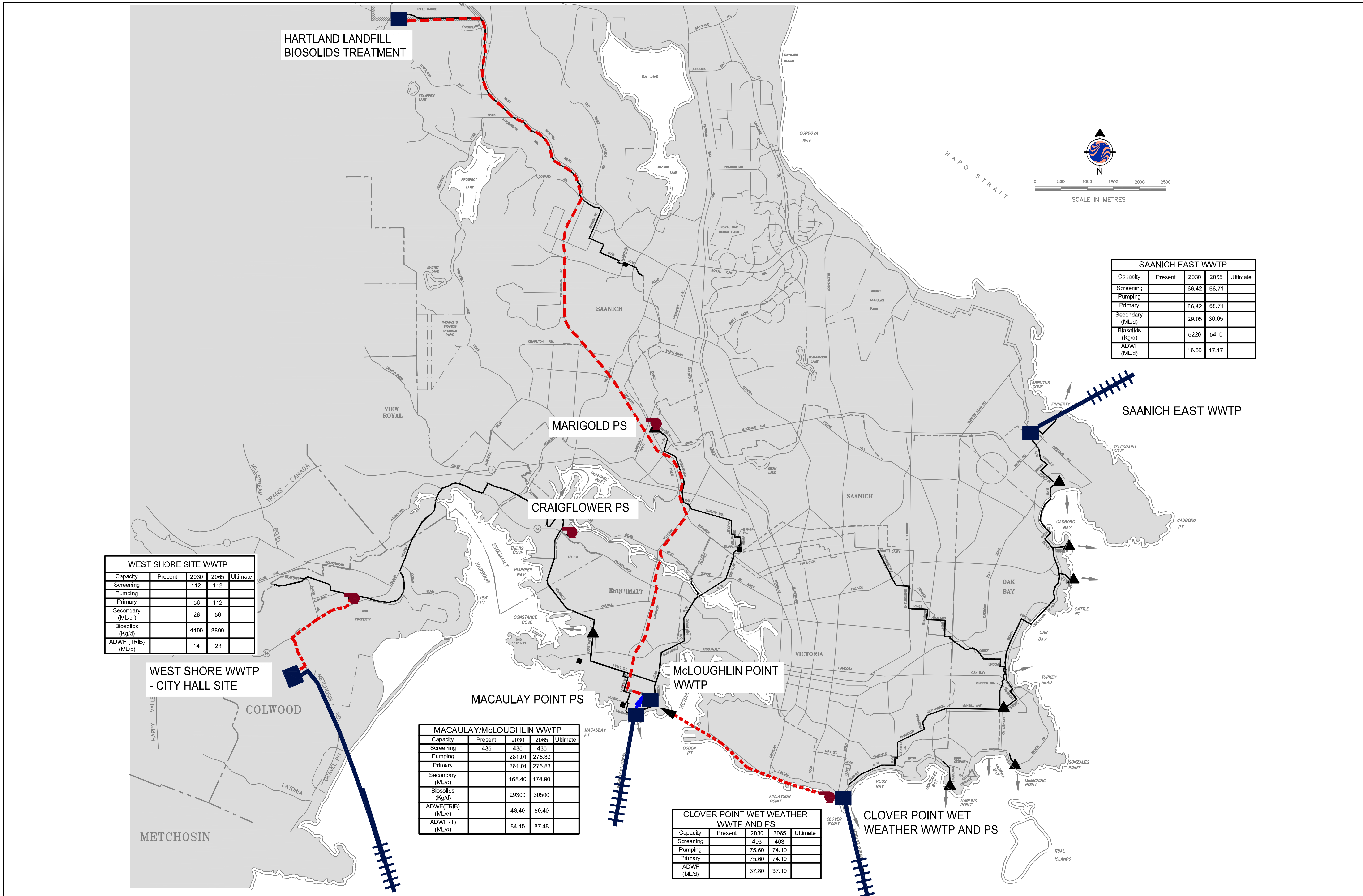
The primary goals outlined by the CRD Board for the CAWTP are:

- Protect public health and the environment.
- Manage wastewater in a sustainable manner.
- Provide cost effective wastewater management.

1.5 Description of Selected Wastewater Treatment Plan – Option 1A

1.5.1 Option 1A

The facilities to be constructed under Option 1A are illustrated in **Figure 1.1** and summarized in **Table 1.1**. Under Option 1A facilities would be constructed at Saanich East - North Oak Bay, Clover Point, Macaulay / McLoughlin Point, Hartland Landfill and the West Shore. There has been some discussion with the BC Ministry of Environment regarding the possible deferment of the Clover Point wet weather plant as the frequency of wet weather flows greater than 2 times ADWF is low. These discussions have not been finalized, therefore wet weather treatment facilities at Clover Point are included in the current plan. Given that CRD is reviewing the opportunities for municipalities to establish inflow and infiltration reduction program, funds may be better spent on improvements to the collection system rather than wet weather treatment. For the purpose of this report, wet weather treatment facilities at Clover Point are included in the plan until the Ministry of Environment provides approval for elimination of wet weather facilities at Clover Point. Pumping, conveyance and outfall construction would also be required as part of the overall treatment strategy for CRD.



WEST SHORE SITE WWTP				
Capacity	Present	2030	2065	Ultimate
Screening		112	112	
Pumping				
Primary		56	112	
Secondary (ML/d)		28	56	
Biosolids (Kg/d)		4400	8800	
ADWF (TRIB) (ML/d)		14	28	

MACAULAY/McLOUGHLIN WWTP				
Capacity	Present	2030	2065	Ultimate
Screening	435	435	435	
Pumping		261.01	275.83	
Primary		261.01	275.83	
Secondary (ML/d)		168.40	174.90	
Biosolids (Kg/d)		29300	30500	
ADWF(TRIB) (ML/d)		46.40	50.40	
ADWF (T) (ML/d)		84.15	87.48	

SAANICH EAST WWTP				
Capacity	Present	2030	2065	Ultimate
Screening		66.42	68.71	
Pumping				
Primary		66.42	68.71	
Secondary (ML/d)		29.05	30.05	
Biosolids (Kg/d)		5220	5410	
ADWF (ML/d)		16.60	17.17	

CLOVER POINT WET WEATHER WWTP AND PS				
Capacity	Present	2030	2065	Ultimate
Screening		403	403	
Pumping		75.60	74.10	
Primary		75.60	74.10	
ADWF (ML/d)		37.80	37.10	

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Capital Regional District | Environmental Services

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SCALE VERTICAL — | APPROVED RAF

CORE AREA WASTEWATER TREATMENT PROGRAM

OPTION 1A
KEY PLAN

CONTRACT NUMBER — | DRAWING NUMBER FIG. 1.1 | ISSUE — | SHT. No. — OF —

Table 1.1
Major Facilities to be Constructed Under Option 1 A

Location	Description of Facility
Saanich East - North Oak Bay	New secondary plant, new outfall collection system modifications, influent pumping station, solids discharged to collection system.
Clover Point	Wet weather treatment for 2 - 4 x ADWF, pump station and forcemain to McLoughlin Point to transfer flows up to 2 X ADWF for secondary treatment. Screening for all flows above 4 X ADWF. Wet weather treatment plant could be deferred or eliminated pending discussions with Provincial and Federal regulators.
McLoughlin Point	Secondary treatment plant to treat flows from Macaulay and Clover catchments up to 2 x ADWF. Primary treatment for all flows up to 4 X ADWF. Screening for all flows above 4 X ADWF. Pump station at Macaulay to convey flows to McLoughlin for treatment.
Hartland Landfill	Regional biosolids treatment facility to treat biosolids from the McLoughlin Point plant and West Shore.
Macaulay Point	Pump Station to convey flows to McLoughlin Point. Macaulay wet weather flows are treated at McLoughlin.
West Shore Plant	New Secondary Treatment Plant facility serving only West Shore communities at location to be confirmed.
Conveyance Facilities	Forcemain to transfer flows from Clover Point to McLoughlin Tunnel or forcemain to transfer flows to McLoughlin. Sludge forcemain and pumping stations to transfer flows to Hartland landfill biosolids treatment facility.
Outfalls	New Outfalls at Saanich East - North Oak Bay, Macaulay and West Shore
Resource Recovery	Water reuse facilities built into plant designs at Saanich East - North Oak Bay, McLoughlin, and West Shore. Heat recovery from effluent built into Saanich East - North Oak Bay, McLoughlin and West Shore Plants. Biosolids resource recovery including co-digestion, production of soil amendment, recovery and sale of biogas, and phosphorus recovery.

1.6 FACILITY SITING

There are a number of factors which must be considered when siting a wastewater treatment facility. These include availability of land, probability of rezoning, cost of land, proximity to the major trunk sewers, room for future expansion, constructability and many other factors. One of the most important factors is the availability of sites for purchase, use of existing sites already under the control of CRD member communities. The CRD has engaged the services of Westland Resource Group to assist in the identification of candidate sites for the treatment plants. Westland has used a triple bottom line approach to assist in identification of candidate sites for sewage treatment. The sites currently under consideration for the various facilities are summarized in **Table 1.2**. It is noted that these sites have not been finalized and further public consultation and social environmental reviews need to be completed.

Table 1.2
Current Siting Opportunities for Treatment Facilities

Location	Potential Facilities	Comments
Saanich East - North Oak Bay	Secondary Treatment Plant	Three potential sites identified and under consideration, one owned by CRD.
Clover Point	Wet weather treatment and pumping	Existing site with limited available space, but adequate for wet weather treatment facilities.
McLoughlin Point	Secondary Treatment Plant	New site which would require purchase and remediation. Risk associated with remediation and schedule impacts. One of the only available sites which could be purchased in the Core Area. CRD has a MOU to purchase.
Macaulay Point	Wet weather treatment and pumping	Existing site with limited available space but adequate for wet weather treatment and pumping. Adjacent land owned by DND. If land could be obtained from DND sufficient space may be available for a new plant.
West Shore – TBD	Secondary Treatment Plant	Site Selection in progress.
Hartland Landfill	Biosolids Treatment and Processing Facility, Future Waste to Energy Facility	Site is owned and operated by CRD.

The approximate area for plant construction at each site is provided in **Table 1.3**. These areas are preliminary and will be refined as further work is completed.

Table 1.3
Approximate Area for Plant Construction

Site	Area (ha)
Saanich East - North Oak Bay	1.5
McLoughlin Point	1.7
Clover Point	No additional land required
Macaulay Point	No additional land required
West Shore	1.5
Hartland Landfill Biosolids Site (Option 1A)	2

The final area requirements will vary slightly depending on final facility design and layout.

Section 2 Design Criteria for New Facilities

This section provides background for the selection of design criteria for new Wastewater treatment facilities.

2.1 Catchment Areas

The sanitary catchment areas under consideration include the following:

- **Saanich East - North Oak Bay** – The proposed treatment plant (common to all options) to be located at an as yet undecided location is intended to reduce the flow reaching Clover Point and provide highly treated effluent for a number of reuse opportunities in the University of Victoria area.
- **Clover Point** – Flows from the reduced catchment area (after construction of the upstream Saanich East - North Oak Bay facility) will be redirected to McLoughlin Point, provided with primary and secondary treatment before discharge, or provided with screening and primary treatment before discharge (depending on the magnitude of the flow and the Option being considered).
- **McLoughlin / Macaulay Points** – Flows from the Macaulay tributary area plus transferred flows from Clover Point will be provided with secondary treatment prior to marine discharge.
- **West Shore** – West Shore tributary flows will be afforded various levels of treatment plus discharge or reuse, depending on the option being considered. It is expected that tertiary treatment for reuse will be able to rise quickly as new development areas are brought on-stream in the West Shore communities.

2.2 Current Liquid-Train Regulatory Requirements

Both the Province of BC and the Government of Canada have regulations and/or guidelines that must be considered for receiving water discharge of treated wastewater. Various reuse scenarios also require adherence to stipulated regulations. A wastewater management system is being proposed that consists of ocean discharge of treated effluent plus an increasing amount of effluent reuse. Because of the time constraints imposed by the Province, the equivalent of secondary treatment prior to discharge is required by the end of 2016. Additionally, there are some aspects of the effluent quality requirements that have recently been announced by the Canadian Council of Ministers of the Environment (CCME) that will also have to be satisfied.

2.2.1 Provincial Regulation

In a BC Provincial document entitled "Municipal Sewage Regulation" (MSR) B.C. Regulation 129/99 under the Provincial Environmental Management Act, specific requirements for treated effluent quality are listed. If the treated effluent is to be discharged to the "open marine" environment, the regulations stipulate that secondary treatment (defined as effluent containing no more than 45 mg/L each of BOD and TSS at any time) must be provided for all flows up to 2 x ADWF. The limiting concentration values may be interpreted as values that are never to be exceeded, regardless of the type of sample taken.

If flows in excess of 2 times ADWF occur more than once every 5 years, a waste management plan or specific study must be undertaken to determine what treatment level is recommended for such occurrences. If the high flow does (Refer to MSR Section 17(1) and (2)) occur more frequently than once every five years, then the equivalent of primary treatment is acceptable for that high flow period. Primary treatment is defined under the MSR as being able to provide an effluent quality with a $cBOD_5$ of not more than 130 mg/L and a total suspend solids of not more than 130 mg/L. In the CRD system, flows in excess of 2 x ADWF do occur more frequently than once every five years at the Clover Point outfall.

In Schedule 2 of the MSR regulations there are listed both "treatment requirements" and "effluent quality requirements" for treated wastewater that is intended to be used as reclaimed water for a variety of end uses, including irrigation of various crops, landscape irrigation, outside wash water, outside fountains, and toilet flushing. The specific treated effluent constituents listed are pH, BOD, turbidity, and coliform organisms. Any such uses being contemplated by the CRD will have to comply with Schedule 2. The MSR may also require disinfection for discharge to areas where recreational use is frequent or shellfish harvesting is completed.

2.2.2 Federal Initiatives

The Canadian Council of Ministers of the Environment (CCME) is comprised of the environment ministers of the federal, provincial and territorial governments. The Council meets at least once per year and focuses on issues that are national in scope and that require collective action by a number of governments. The purpose of the CCME is to assist its members to meet their mandate of protecting Canada's environment. While the CCME is a collaborative effort, each minister remains accountable to his/her government according to the laws and statutes governing their jurisdiction.

Over the past five years, the CCME has been developing the Canada-Wide Strategy for the Management of Municipal Wastewater Effluent, known as "the CCME Strategy" recently endorsed by the CCME Council of Ministers on February 17, 2009. In August 2009 the Federal Minister of Environment announced stricter effluent regulations which will require all communities to have wastewater treatment. Environment Canada has taken the lead in coordinating this effort. Among other things, the CCME Strategy establishes National Performance Standards to be considered, and minimum performance requirements for effluent quality from all municipal, community and government wastewater facilities that discharge municipal wastewater effluent to surface water. The Federal National Performance Standards for wastewater treatment facilities of a size likely to be installed in the Capital Regional District are:

- $cBOD_5 \leq$ 25 mg/L (monthly average of at least five samples per week);
- TSS ≤ 25 mg/L (monthly average of at least five samples per week);
- Total residual chlorine ≤ 0.02 mg/L (testing is required only if chorine is used as a disinfectant in the treatment facility; testing to be done three times per day if required).

The monthly average $cBOD_5$/TSS concentration limits of 25/25 mg/L contained in the CCME National Performance Standards generally are equivalent to the Provincial not-to-exceed concentration limits of 45/45 mg/L for the same parameters.

Wastewater facilities with flow rates in excess of 2,500 m^3/d, are also required to conduct whole effluent acute toxicity testing and evaluate chronic toxicity at the edge of a specified mixing zone. Given the likely size of the future CRD wastewater treatment facilities, toxicity testing will probably be a monthly requirement. If a facility fails an acute toxicity test, a toxicity reduction and evaluation process is used to identify and correct the cause of the toxicity. If the whole effluent acute toxicity test failure is due to ammonia, then the need for ammonia reduction must be determined on the basis of the assimilative capacity of the receiving environment. Given the BOD_5 and TKN concentrations previously reported for Macaulay Point and Clover Point respectively, and making a simplistic assumption that 0.5 grams of biosolids containing 8% nitrogen will be produced for every gram of BOD_5 removed, the conservatively high estimates for the treated effluent ammonia-nitrogen concentrations from treatment plants located at Macaulay and Clover Points would be in the order of 38 mg/L and 31 mg/L respectively. From an examination of the plot given in **Figure 2.1**, it is unlikely that the future ammonia-nitrogen concentrations in CRD's treated effluent will be an issue for disposal to marine waters, presuming that the pH is less than about 7.8. Initial discussions with Environment Canada indicate that it is unlikely that nitrification would be required for discharge to marine waters.

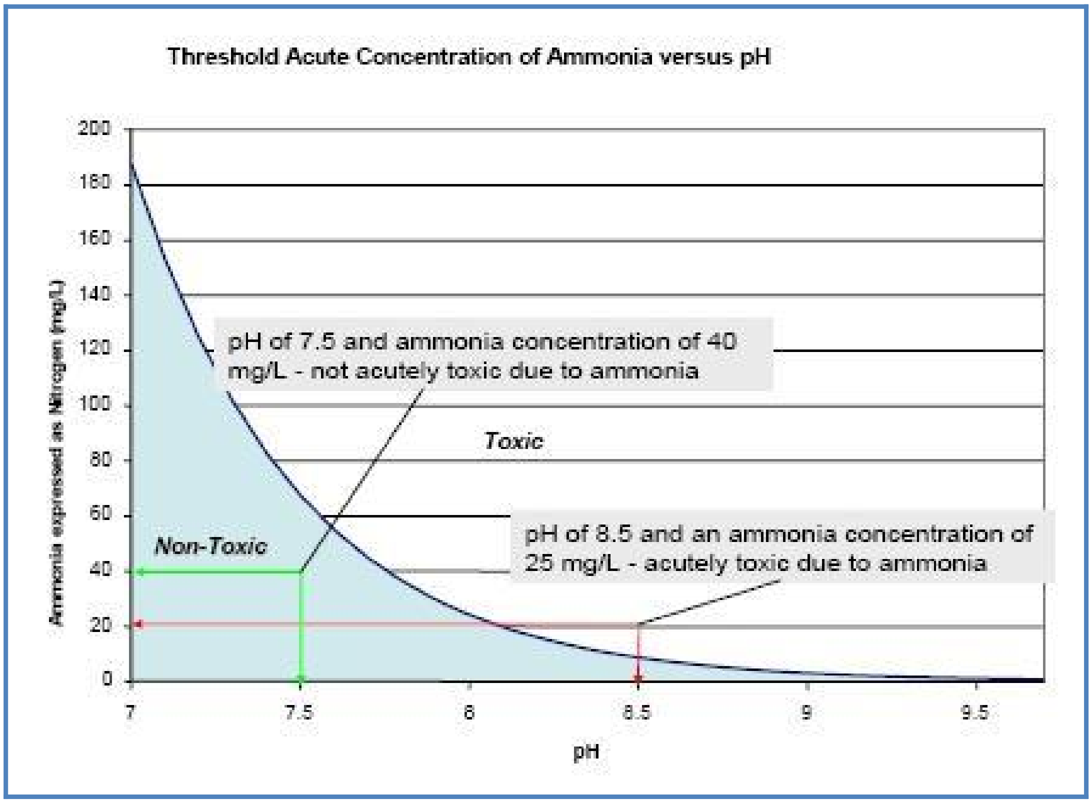

Figure 2.1
Acute Toxicity Relationship Between pH and Ammonia-Nitrogen Concentration
(after Environment Canada, 2007)

2.3 Flexibility for Potential Future Regulatory Changes

There are currently a number of generally present impurities in municipal sewage that are being studied to determine if effluent regulations should be expanded to include some measurable limits. The two main groups of impurities that are candidates for limitations in the CRD setting are probably Greenhouse Gas (GHG) agents and microconstituents such as endocrine disrupting compounds (EDCs), pharmaceutically-active compounds (PhACs), and personal care products (PCPs). These compounds are often referred to as Compounds of Emerging Concern (COEC). Every effort should be made to ensure that any treatment facilities being designed in the near future include a capability for easy addition of treatment reduction for the above impurities of concern should they be necessary in the future. It is unlikely that more stringent nutrient removals will be required for open marine discharge, but many reuse opportunities and any potential surface water discharges will be affected by more stringent effluent nutrient limits.

2.4 Biosolids Regulatory Requirements

In British Columbia biosolids regulations called the “Organic Matter Recycling Regulation” have been issued under the Environmental Management Act and the Health Act. The regulations provide for two classes of biosolids, Class A and Class B, whose characteristics are summarized in **Table 2.1**. Class A biosolids are processed to a higher degree than Class B biosolids, thus having a much lower pathogen concentration in the finished product and have much less restrictive handling and land application requirements. In some respects, the regulation is similar to the U.S. EPA Regulation 503 for biosolids.

The Organic Matter Recycling Regulation also specifies requirements for Classes A and B compost as well as the maximum allowable metal concentrations in biosolids, compost and soils following land application.

Table 2.1
Summary of Biosolids Classification Requirements in BC’s Organic Matter Recycling Regulation

Characteristic	Class A Biosolids	Class B Biosolids
Pathogen Reduction Requirements	<1,000 MPN per gm (dry solids basis) to be produced by one of the pathogen reduction processes listed below	<2,000,000 MPN per gm (dry solids basis) or one of the pathogen reduction processes listed below
Acceptable Processes for Pathogen Reduction	Thermophilic aerobic digestion at ≥ 55ºC for at least 30 min	Aerobic digestion with mean cell retention time between 40 days at 20ºC and 60 days at 15ºC
	Thermophilic anaerobic digestion at ≥ 50ºC for at least 10 days	Anaerobic digestion with a mean cell retention time between 15 days at 35ºC and 60 days at 20ºC
	Exposure to time-temperature processing requirements according to arithmetical formulae given in the regulation depending on the total solids concentration of the biosolids	Air drying for >3 months, during which the ambient temperature must be >0ºC for at least 2 months
	Alkaline stabilization by maintaining the pH within the biosolids >12 for 72 hours during which T > 52ºC for 12 hours, followed by air drying to >50% total solids concentration	Lime stabilization such that the pH of the biosolids is raised to ≥ 12 after 2 hours of contact
Vector Attraction Reduction Requirements	Aerobic or anaerobic digestion resulting in >38% destruction of volatile solids mass or another acceptable criterion specified in the Regulation	Aerobic or anaerobic digestion resulting in >38% destruction of volatile solids mass or another acceptable criterion specified in the Regulation

New biosolids treatment facilities should be designed to meet the above regulations for the specific class of biosolids and treatment process selected.

2.5 Odour Control

Odour emissions from wastewater collection and treatment systems are certainly nothing new. Regardless, neither the BC Municipal Sewage Regulation nor the Organic Matter Recycling Regulation includes specific requirements for odour control. It is reasonable to assume that the public will be intolerant of offensive odours from the new wastewater facilities and thus state of the art odour control equipment needs to be installed to mitigate odours to a reasonable level. It is possible that future regulations could be promulgated employing quantitative odour monitoring such as dilutions to threshold (D/T) at the plant fence line or at the nearest downwind receptor. However such regulations are not on the immediate horizon. All of the proposed liquid stream plants under the selection Option 1A are in close proximity to existing development so odour mitigation is included in all designs.

2.6 Wastewater Characteristics

For purposes of process design of liquid train treatment facilities and for estimation of produced biosolids which need to be handled and treated before final utilization or disposal, the comparison of options has been based on a "standard" sewage strength throughout the region following a review of limited wastewater characterization data collected by CRD. Once specific processes have been decided for each treatment site chosen, both the design flows and the design impurity loads will be estimated more closely on a site-by-site basis during the pre-design phase of the project. For this preliminary planning work the approach that has been used is adequate.

For those unit processes at each site that need to be designed on the basis of flow (eg – headworks, primary clarifiers and MBR facilities) the flows mandated by the Provincial regulators have been used, while for the unit processes that need impurity loads for design sizing, BOD_5 and TSS concentrations in the raw wastewater have been taken as 240 mg/L and 195 mg/L respectively at ADWF conditions. Process design sizing has been set at 1.3 times (with exception of Saanich East where 1.75 x ADWF is used for blending) the ADWF conditions so that the process will still provide the mandated effluent quality with flows up to 2 x ADWF, as mandated by the Provincial Regulators.

2.7 2030 and 2065 Design Flow

The design flows used in the following tables are directly derived from the mandated treatment flows sent to CRD by the Provincial Minister of Environment. In summary, these flows and their respective treatment requirements are:

- The equivalent of secondary treatment for up to 2 x ADWF at each discharge point. Secondary treatment is described in the Regulations as meaning never-to-be-exceeded values of 45 mg/L for both BOD_5 and TSS. The Federal requirement is to be 25 mg/L for both BOD_5 and TSS based on a monthly average. This is similar to the provincial not to exceed standards.

- The equivalent of primary treatment for flows between 2 x ADWF and 4 x ADWF if flows greater then 2 x ADWF occurs more than once in every five years.
- Screening of all flows in excess of 4 x ADWF before discharge to the marine environment. It is expected that all screened flows in excess of 4xADWF will meet equivalent to primary treatment requirements of 130 mg/L BOD_5 and 130 mg/L TSS.

In the construction of the tables below, these requirements have been adhered to, although in some cases a portion of the flow at any chosen discharge site has been transferred to another discharge site for such treatment when site conditions or costs indicate such a transfer is beneficial.

Since all specific treatment sites have not yet been definitely chosen, some slight revisions to a given plant design flow will probably occur at the time of pre-design activities. However, such slight adjustments will almost assuredly have no implications on the choice of option that is ultimately made.

2.7.1 Option 1A Design Flows

Option 1A was originally proposed by the consultants who carried out the first phase of the project study. This option includes four nodes where some form of treatment is provided, and where an outfall for the ocean disposal of at least a portion of the tributary area. The four chosen locations are Saanich East - North Oak Bay, Clover Point, McLoughlin Point, and West Shore.

The following **Table 2.2** for the **Saanich East - North Oak Bay Plant** provides estimates of design flows which need to be treated to the stipulated level of secondary, primary, or screening only at a site in close proximity to the University of Victoria. Such a site is deemed to have an excellent chance to make substantial use of reuse and recovery opportunities within the university community. For that reason, the treatment process selected is as the previous consultants recommended, which involves the use of membrane bioreactors (MBR) which are capable of producing a plant effluent that is ready-made for many reuse and recovery opportunities. Because of its very high efficiency of treatment, it is not necessary to actually provide a capacity of 2 x ADWF in order to meet the mandated secondary treatment requirement mandated for those periods of time when discharge is through an ocean outfall. By designing the MBR plant to accept 1.75 x ADWF, its effluent can be combined with 0.25 x ADWF that has only received primary treatment, with the recombined blended stream still meeting the mandated secondary treatment level being suggested by the CCME. This approach will result in capital cost savings for the membrane component of the treatment process.

Given that there is very little difference between the 2030 and 2065 design flows (0.6 ML/d) all process tankage should be designed for the 2065 flow and installation of membranes staged to easily accommodate increasing flows. It is noted that there are also other technologies such as conventional and disc filtration which could also provide a high quality effluent for reuse. These options can be explored at the pre-design phase.

All solids removed from the liquid stream at Saanich East - North Oak Bay will be put back into the trunk sewer servicing Clover Point for further forwarding to McLoughlin/Macaulay plant. The initial phase of the project may require temporary dewatering depending on the timing of construction of downstream biosolids processing facilities.

Table 2.2
Option 1A - Saanich East - North Oak Bay WWTP Design Hydraulic Flows

Item	2030		2065	
	Flow (ML/d)	Action	Flow (ML/d)	Action
ADWF	16.6		17.2	
1.75 x ADWF	29.0[1]	On-site sec. (MBR)	30.1	On-site sec. (MBR) + reuse or outfall
1.75 ADWF – 4 x ADWF	37.4	On-site prim. only	43.0	On-site prim. Only + outfall discharge
Filtration for Reuse	29.0	≅12 ML/d guaranteed[2]	30.1	≅12 ML/d guaranteed
>4 x ADWF	≅ 30	Screening + outfall	≅ 32	Screening + outfall
Biosolids		Discharge to Clover		Discharge to Clover

Notes:

1. By combining the 1.75 ADWF MBR effluent with 0.25 ADWF of PE, the secondary treatment requirement for 2xADWF can be easily met (25 mg/L BOD_5 /25mg/L TSS).
2. The amount of highly treated reuse water that can be more or less always available is something less than the ADWF.

Table 2.3 below shows the design flow expectations at **Clover Point**, along with the expectations for the various treatment requirements and where those flow ranges will be sent. This Option assumes that 2 x ADWF will be sent to McLoughlin/Macaulay Points for secondary treatment plus some reuse, while the flows between 2 and 4 times ADWF will be provided with primary treatment plus ocean disposal at Clover Point. All solids removed by such primary treatment will be sent on to McLoughlin/Macaulay for further treatment. The same protocol will be used for the flows in excess of 4 x ADWF which will be afforded screening before outfall discharge.

Table 2.3
Option 1A - Clover Point Wet Weather WWTP Design Hydraulic Flows

Item	2030		2065	
	Flow (ML/d)	Action	Flow (ML/d)	Action
ADWF	37.8		37.1	
2 x ADWF	75.6	Transfer to McLoughlin	74.2	Transfer to McLoughlin
2 x ADWF – 4 x ADWF	75.6	On-site prim to outfall	74.2	On-site prim to outfall
>4 x ADWF	≅40	On-site screening to outfall	≅40	On-site screening to outfall
Biosolids		Discharge to McLoughlin / Temporary Dewater		Discharge to McLoughlin / Temporary Dewater

In Option 1A, the **McLoughlin / Macaulay Points site** is to be designed to accept the total flows from its own tributary area plus Clover Point design flows that are between 2 and 4 times ADWF. All biosolids from the McLoughlin Point, Clover Point, and Saanich East - North Oak Bay plants will be treated and dried (as appropriate) at an Hartland landfill biosolids treatment facility. Other nearby sites may also be considered if they can be purchased from current owners.

Table 2.4 shows the anticipated design flows for the various liquid treatment levels that are required to meet the provincial mandate. The values for tertiary treatment flows are provisional estimates of what flows might have a market for reuse or recovery in the two time frames being considered.

Table 2.4
Option 1A - McLoughlin / Macaulay Point WWTP Design Hydraulic Flows

Item	2030		2065	
	Flow (ML/d)	Action	Flow (ML/d)	Action
ADWF(tributary)	46.4		50.4	
2 x ADWF(tributary)	92.8	On-site Secondary	100.8	On-site Secondary
2 x ADWF (from Clover)	75.6	On-site Secondary	74.1	On-site Secondary
Total design flow of 2 x ADWF	168.4	On-site Secondary	174.9	On-site Secondary
2 x ADWF – 4 x ADWF(tributary)	92.8	On-site primary only	100.8	On-site primary only
>4 x ADWF(tributary)	≅50	On-site screening to outfall	≅55	On-site screening to outfall
Filtration for Reuse	12[1]		24	
Biosolids		To separate site		To separate site

1. The amount of reuse water will vary depending on actual demand.

Within Option 1A, the previous consultants recommended that a separate plant be constructed on the West Shore to provide the necessary treatment levels for the new developments that are expected to occur in that area, plus any conversions of septic tank systems that are near the route of trunk sewers serving the new plant. That recommendation is being used in this assessment. However, there may be justification for changing the boundary between the West Shore plant tributary area and the McLoughlin Point tributary area through some further wastewater diversion to make better use of the restricted site at McLoughlin Point, or of the staging possibilities at the West Shore plant site.

Table 2.5 shows the flow expectations and the treatment levels required to meet the Provincial mandate at the various flow conditions for the **West Shore** site. All biosolids generated will be treated on site. Again, an allowance has been made for tertiary treatment of a portion of the plant effluent that can be reasonably expected to be in demand for recycle or reuse in the newly developing areas of the West Shore.

Table 2.5
Option 1A - West Shore Design Hydraulic Flows

Item	2030		2065	
	Flow (ML/d)	Action	Flow (ML/d)	Action
ADWF	24.1*	Initial phase 14 ML/d	38.3	
2 x ADWF	48.2	On-site secondary	76.6	On-site secondary
4 x ADWF – 2 x ADWF	48.2	On-site primary only	76.6	On-site primary only
Filtration for Reuse	6[1]	On-site post-filtration	18	On-site post-filtration
>4 x ADWF	≅30	On-site screening to outfall	≅40	On-site screening to outfall
Biosolids		On-site treatment		On-site treatment

1. The amount of reuse water can be increased to supply additional demands if necessary.
2. *The flow from Colwood and Langford served by the West Shore plant at the end of the 2016 program will be approximately 7.5 ML/d. For phasing and costing in the initial stage of construction a flow of 14 ML/d has been used.

2.8 2030 and 2065 Design Loads

Most unit processes in a conventional secondary treatment plant are designed on the basis of BOD_5 and TSS loads expected to enter that plant in the design year. For purposes of this option comparison, some assumptions have been made that are considered to be appropriate for making a decision on which of the Options (or modified Option) should be taken the next step to the pre-design phase. The assumptions (based on both available data on CRD wastewater characteristics and accepted design practice) that were used are listed below.

- A raw sewage ADWF BOD_5 of 240 mg/L has been used for all tributary areas.

- A raw sewage ADWF TSS of 195 mg/L has been used for all tributary areas.
- A primary clarification efficiency of 55% has been used for TSS removal.
- A primary clarification efficiency of 30% has been used for BOD_5 removal.
- A net yield factor of 0.8 has been used for conversion of primary effluent (PE) BOD_5 to secondary solids.
- A factor of 1.3 has been applied to ADWF load to account for increases in loads that occur at flows above ADWF conditions (i.e. maximum month load conditions).

It has been assumed that flows greater than 2 x ADWF occur so infrequently and at reduced BOD and TSS concentration, that the use of the 1.3 multiplying factor will more or less account for the biosolids load at flows up to that value of 2 x ADWF. These factors can range from 1.1 – 1.4 ADWF depending on the characteristics of the catchment area, commercial and industrial contributions and I & I. For preliminary analysis 1.3 is deemed appropriate. This factor is used to account for maximum month load conditions for process design. For the peak 14 day load period for preliminary digester sizing, a value of 1.4 x ADWF was used.

2.8.1 Option 1A Design Loads

Using the values described above, the design loads for the Saanich East - North Oak Bay facility were estimated, and the results entered into **Table 2.6** below. Additionally, the calculated design mass of biosolids produced per day at the design loads are entered.

Table 2.6
Option 1A - Saanich East - North Oak Bay Secondary Treatment Design Loads

Item	Flow (ML/d)	Conc. (mg/L)	Load (kg/day)	Action
ADWF BOD_5	17.2	240	4,130	
ADW TSS	17.2	195	3,350	
Process Des. BOD_5 (1.3 x ADW)			5,370	On-site treatment with MBR
Process Des. TSS (1.3 x ADW)			4,360	
Primary Biosolids (55% removal)			2,400	To Clover Point
Second. Biosolids (30% removal in PC) (0.8 yield factor)			3,010	To Clover Point

Note: 2065 ADWF used because it is estimated to be only marginally higher than 2030 value.

Since no secondary treatment is considered at Clover point, there will be no primary or secondary biosolids to separately account for at that site. The BOD_5 and TSS loads in the sewage up to 2 x ADWF will simply be pumped on to McLoughlin/Macaulay for inclusion in the treatment loads at that site. The biosolids from Saanich East - North Oak Bay will simply be passed on down the line to McLoughlin/Macaulay. These numbers are summarized in **Table 2.7**.

Table 2.7
Option 1A - Clover Point Primary Treatment Design Loads

Item	Flow (ML/d)	Conc. (mg/L)	Load (kg/day)	Action
ADWF BOD_5	37.8	240	9,070	
ADWF TSS	37.8	195	7,370	
Process Des. BOD_5 (1.3 x ADW)			11,790	To McLoughlin
Process Des. TSS (1.3 x ADW)			9,580	To McLoughlin
Primary Biosolids (55% rem.)			5,270	
Second. Biosolids (30% rem in PC) (0.8 yield factor)			0	
Biosolids from Saanich East - North Oak Bay			5,410	To McLoughlin

The proposed secondary treatment facilities at McLoughlin/Macaulay for Option 1A will be capable of providing secondary treatment to flows up to 2 x ADWF from both the Macaulay Point catchment and the Clover Point catchment. In addition the site will provide primary treatment only for tributary flows between 2 and 4 times ADWF, and biosolids treatment is envisaged either at McLoughlin Point or some yet to be selected nearby site. These design loads are summarized in **Table 2.8**.

Table 2.8
Option 1A - McLoughlin/Macaulay Secondary Treatment Design Loads

Item	Flow (ML/d)	Conc. (mg/L)	Load (kg/day)	Action
ADWF BOD_5	46.4 + 37.8 from Clover	240	20,210	
ADWF TSS	46.4 + 37.8 from Clover	195	16,420	
Process Des. BOD_5 (1.3 x ADWF)			26,270	On-site secondary
Process Des. TSS (1.3 x ADWF)			21,350	On-site secondary
Extra TSS from Saanich East - North Oak Bay			5,410	On-site secondary
Primary Biosolids (55% rem.)			14,720	
Second. Biosolids (30% rem in PC) (0.8 yield factor)			14,710	
Total biosolids			29,430	Off-site treatment

In Option 1A the proposed works at a West Shore site will be designed to treat tributary flows from newly developed areas of the West Shore communities and from some properties currently serviced by septic tanks. Secondary treatment is provided for flows up to 2 x ADWF, and primary treatment is provided for flows between 2 and 4 times ADWF. Flows in excess of 4 x ADWF are to be screened before ocean discharge. An allowance has been made for tertiary treatment of a portion of the secondary effluent for reuse and recovery purposes, with such flows being identified in Table 2.5, since hydraulic design (rather than impurity load) governs such treatment. This information is summarized in the following **Table 2.9**.

Table 2.9
Option 1A - West Shore Secondary Treatment Design Loads

Item	Flow (ML/d)	Conc. (mg/L)	Load (kg/day)	Action
ADWF BOD_5	14	240	3,360	
ADWF TSS	14	195	2,730	
Process Des. BOD_5 (1.3 x ADWF)			4,370	On-site secondary treatment
Process Des. TSS (1.3 x ADWF)			3,550	On-site secondary treatment
Primary Biosolids (55% rem.)			1,950	
Second. Biosolids (30% rem in PC) (0.8 yield factor)			2,450	
Total Biosolids			4,400	On-site

Section 3 Liquid Train Treatment for Option 1A

3.1 General

This section discusses liquid train wastewater treatment for the treatment plants serving CAWTP. All plants will use secondary treatment technology that has been proven at other locations.

3.2 Representative Secondary Treatment Technologies

To enable preparation of cost estimates and assessment of siting, representative treatment technologies have been selected for this evaluation. The representative technologies all use proven secondary wastewater treatment processes which will meet the regulatory discharge objectives and which have been constructed at numerous other locations in North America and Europe.

When undertaking a major wastewater treatment program such as the CRD, the CRD will be inundated with many new and novel technology suppliers who make many claims with respect to process performance and cost. While many of these technologies show promise, most have no track record or history at the scale of facilities required for CRD. Any future assessments of these novel technologies should consider the long term operating costs, reliability and track record at a similar scale.

Considering the discussion on effluent requirements in Section 2 of this report, a biological treatment plant capable of producing an effluent quality (never to be exceeded) of 45 mg/L BOD5 and TSS will need to be provided for each of the plants serving the CRD for flows and organic loads up to 2 times ADWF. This is the Provincial Ministry of Environment standard for effluent discharge via outfalls to the open marine environment. The same plant must also meet the proposed Federal National Standards (CCME) of an average monthly $cBOD_5$ of 25 mg/L and TSS of 25 mg/L. Such an effluent quality can reliably be met or exceeded by a range of treatment technologies including: conventional activated sludge systems (CAS), or fixed film systems such as trickling filter/solids contact (TF/SC) and biological aerated filter (BAF) processes, or hybrid systems which incorporate characteristics of both suspended growth and fixed film processes such as Integrated Fixed Film Activated Sludge (IFAS) processes or moving bed bioreactors (MBBR). Membrane bioreactor (MBR) activated sludge systems as previously proposed were also considered appropriate because of their small footprint and their potential for water reuse.

For municipal applications proven processes which have a track record at other locations throughout North America were only considered. While there are a number of new and emerging technologies being promoted by many suppliers, their track record, performance and operating cost is unproven at the scale required for the CRD installation. A preliminary assessment of secondary process options based upon relative capital and operating cost and track record in Canada and USA as well as such considerations as aesthetics of the facilities resulted in the following choices of technology for CRD:

- Conventional Activated Sludge (CAS) for sites with no space limitation (West Shore).
- Biological Aerated Filters (BAF) for limited site availability (McLoughlin Point).
- Membrane Bioreactor (MBR) activated sludge systems for locations where visual aesthetics is especially important, where effluent reuse potential exists, as well as where site space limitations are a reality (Saanich East - North Oak Bay).
- All plants have the capability of providing a portion of water with filtration or membrane filtration to permit water reuse.

A goal of the CRD Core Area Wastewater Treatment Program project is to optimize the amount of resource recovery from each of the liquid train wastewater treatment and biosolids processing facilities developed to serve the sewered area. This includes reuse of the effluent for irrigation and utilization for toilet flushing purposes. For both of these reuse purposes the degree of treatment must be high. To maximize the potential for effluent reuse the initial concepts for sewage treatment were based on the use of membrane bioreactors (MBR's) which are essentially a small footprint activated sludge systems which use permeable membranes for separation of biosolids from the effluent. Such systems produce a very high quality effluent (e.g. < 2 mg/L BOD and < 1 mg/L TSS) combined with removal of most microorganisms including bacteria which can be pathogenic. Because of the concentrated biological organism population in the bioreactors preceding the membranes, the long contact time (sludge age), results in conversion of the ammonia in the wastewater to nitrates and subsequently to nitrogen gas through biological nitrification and denitrification provided sufficient alkalinity is available in the wastewater. In the McLoughlin and West Shore plants a small membrane module is included to satisfy reuse elements.

3.3 Option 1A Liquid Train Treatment

Treatment facilities for Option 1A will be located at the same sites as identified for Option 1 proposed by the previous consultants. For Option 1A evaluated in this report, the types and 2030 capacities for the secondary treatment facilities are listed and then discussed below:

- Saanich East - North Oak Bay: A 16.6 ML/day membrane bioreactor (MBR) activated sludge plant with membrane capacity to handle up to 29 ML/d during wet weather conditions.
- Clover Point: A 75.6 ML/d ballasted sedimentation (i.e. Actiflo) wet weather high rate primary treatment plant.

- McLoughlin Point: A 168.4 ML/day biological aerated filter (BAF) secondary. Wet weather facilities for the Macaulay catchment are incorporated into the McLoughlin site by using high rate lamella primaries so there are no wet weather treatment facilities at Macaulay Point.
- West Shore: A 14 ML/d conventional activated sludge plant (CAS).

3.3.1 Saanich East - North Oak Bay MBR

The Saanich East - North Oak Bay plant is intended to be located in close proximity to the University of Victoria. Because of the potential of a portion of the plant flow utilization for effluent reuse for irrigation at the university, the decision was made to provide a high level of treatment i.e. membrane bioreactor technology (MBR) for irrigation, water reuse and heat recovery. The Finnerty Cove outfall also will terminate in marine waters that do not have as high a degree of tidal flushing as the Macaulay and Clover locations on the Strait of Juan de Fuca. The membrane treatment capacity will be designed for 1.75 times ADWF (29 ML/d) and the high quality effluent will be combined with up to 0.25 times ADWF (4.2 ML/d) of primary effluent (to achieve an equivalent effluent load of TSS and BOD as a secondary treatment facility designed for a capacity of 2 times ADWF.

All flows tributary to the plant will be screened using fine 2 mm opening screens.

Flows up to 4 times ADWF 66.4 ML/d will be treated in lamella plate equipped high rate primary settling tanks which will have a surface overflow rate (SOR) of 13 m/hr. Facilities will be available for addition of 70 mg/L of alum and 1.5 mg/L of polymer so that wet weather flows will receive chemically enhanced primary treatment (CEPT). It is expected that the CEP treatment of storm flows will achieve BOD and TSS levels in the primary effluent of about 80 and 60 mg/L respectively.

Primary effluent flows up to 1.75 times ADWF will pass through fine screens (2mm openings) and then flow to a suspended growth bioreactor in which the AS concentration will be maintained at a high level of about 8000 mg/L and the retention time at ADWF will be about 4 hours. This MBR bioreactor will be subdivided into anoxic (no aeration, mechanical mixing only) and aerobic sections which will be aerated to maintain a high dissolved oxygen level of about 2.5 mg/L. The bioreactor tank will be followed by a membrane tank which will contain hollow fibre micro filtration acetate membranes which will achieve separation of the AS from the liquid effluent by applying a vacuum across the semi permeable membranes. A portion of the separated sludge will be returned to the bioreactor as RAS to seed the biological processes. The remainder of the sludge (approximately 5410 kg/day) referred to as waste activated sludge (WAS) will be wasted to the sewer system downstream of the plant towards Clover Point.

The pore size on the membranes will be < 2 microns which will provide a physical barrier to organic and inorganic solids and even to microorganisms including bacteria. The MBR plant quality will be very high, 2 mg/L BOD and < 1 mg/L TSS with very low bacteria populations of 1 or 2 TC/100 ML. During storm flows up to 2 times ADWF, the combined MBR and CEP effluent will easily meet the effluent requirements for discharge to the marine environment. Because of the high AS concentration and long sludge age of > 20 days as well as the process configuration nitrification (ammonia conversion to nitrates) and denitrification will occur insuring no effluent toxicity to fish. The MBR plant effluent will be suitable for reuse for irrigation and use for toilet flushing on the nearby university properties, golf courses and parks. The effluent will be disinfected using UV disinfection and chlorine will be added to maintain a residual.

3.3.2 Clover Point Wet Weather Treatment

A compact design has been developed for the wet weather high rate primary treatment at Clover Point. This facility will use Actiflo™ ballasted flocculation technology and will only operate during wet weather conditions when flows exceed 2 x ADWF. Ballasted flocculation uses a proprietary high rate technology using polymer and a sand ballast to agglomerate the floc particles which results in faster settling, a higher design surface loading rate and a smaller facility footprint. Such facilities are in place at a number of facilities in North America including areas with similar climatic conditions such as Washington State. For preliminary sizing purposes, surface overflow rate is selected at 100 m/hr.

Grit removal facilities will be located upstream of the Actiflo process. Chemical storage facilities will be located in or adjacent to the existing Clover Point pumping station.

3.3.3 McLoughlin Point Biological Aerated Filter

A biological aerated filter (BAF) design provides the most compact design on the limited McLoughlin Point site. BAF is an attached growth process where a polystyrene or shale filter bed in the order of 3 to 4 metres is used as a filter media. The reactor also uses compressed air which is introduced into the filter bed to satisfy oxygen demand of aerobic microorganisms. The yield of excess sludge is similar to activated sludge at between 0.8 to 0.9 kg cells/ kg of BOD removed. In a typical design, multiple filter cells are used so that one can be backwashed approximately once every 24 hours. The backwash is directed to a dirty washwater tank and solids are removed and directed to thickening facilities. The BAF requires no secondary clarifiers so this provides a significant footprint reduction. To meet the new federal requirement of 25 mg/L and BOD/ 25 mg/L TSS the BAF will be designed in a two stage series configuration.

Preliminary layouts indicate the BAF can fit on the McLoughlin site but there will be no space available for biosolids processing. If BAF is selected as the final process the tankage should be sized for the 2065 flow because the incremental increase is minor and it would be difficult to retrofit the plant on a tight site in the future.

Primary clarification is provided at the McLoughlin Point site using lamella plate sedimentation. Process diagrams, design criteria and layouts of the BAF and MBR plants are appended to this report. BAF have been installed at Kingston and Windsor in Ontario and at Canmore, Alberta.

There are also a number of installations in the USA. Several suppliers can provide BAF process equipment.

At McLouglin, because of the confined site the BAF is an ideal candidate but the filter tanks are quite deep which requires significant rock excavation thereby resulting in increased capital costs. The rock excavation will likely assist in reducing remediation costs. It should also provide good foundation conditions.

3.3.4 West Shore – Conventional Activated Sludge System

For the West Shore plant a conventional activated sludge system has been selected for the preliminary design. This system will consist of primary clarification, aeration, secondary sedimentation and disinfection. A water reuse module will also be provided.

Raw wastewater with a BOD of 240 mg/L and TSS concentration of 195 mg/L would first be pretreated by fine screening 6mm openings and grit removal prior to primary settling. These preliminary processes are required to remove floatable solids which are unsightly and would cause odour problems during subsequent processing, and inorganic solids which cause excessive wear on mechanical equipment. In the primary settling tanks organic solids settle out, reducing the TSS load and BOD load to the bioreactors by about 55% and 30%, respectively. Primary sludge is typically thickened to a concentration of about 4% solids and is fed to the anaerobic digestion sludge stabilization facilities. Either circular or rectangular primary sedimentation tanks can be utilized at any of the plants proposed for CRD. Storm flows up to 4 times ADWF will be passed through the primary settling process. To minimize the plant footprint of the primary settling at all of the plant sites, lamella plate high rate settling facilities will be utilized and chemical feed systems added, which at high flow rates between 2 and 4 times ADWF would allow operation as high rate chemically enhanced primaries (CEP) . Alum at a dosage of about 70 mg/L and polymer at a dosage of about 1 mg/L would be applied during these high flow times. The lamella primary tanks would be sized at a surface overflow rate of 13 $m^3/m^2/hr$.

The clarified primary effluent with a BOD of about 170 mg/L and a TSS of about 95 mg/L is introduced into the suspended growth bioreactor tanks where activated sludge (a mixture of microorganisms) grows and adsorbs and biologically degrades the organics in an aerobic environment to produce carbon dioxide, water, and new activated sludge (AS) cells. The activated sludge concentration in the bioreactors is typically operated between 1500 and 3500 mg/L and is kept in suspension by the addition of compressed air added from a blower system and fine bubble diffusers installed at the bottom of the 4 to 5 m deep bioreactors. After a hydraulic retention time of about 6 hours, the contents of the bioreactors, called mixed liquor, is introduced to final settling tanks (secondary clarifiers) where the biological solids are separated from the liquid effluent by gravity. About 70 to 100 % of the activated sludge is pumped back as return activated sludge (RAS) to the head end of the bioreactor to seed and maintain the biological treatment. The remainder of the settled sludge with a solids concentration of about 0.6 to 1.0 % solids is wasted as waste activated sludge (WAS), thickened, and then fed to the anaerobic digesters. During this biological process the liquid effluent concentration is reduced typically to below 10 mg/L BOD and TSS. Layouts for all plants are appended to this report.

3.3.5 Disinfection

The BC Ministry of Environment has requested that UV Disinfection be included in the current planning over concerns regarding potential impact on shellfish. Outfall plume delineation modeling is currently being completed to confirm the requirement for disinfection. For capital budgeting purposes at this time, UV disinfection is included for all plants.

Section 4 Biosolids Treatment Design

4.1 Biosolids Treatment Technology

This section describes how biosolids will be treated and managed for the CAWTP. A detailed Biosolids Management Plan was prepared in November 2009 by the consulting team (Stantec / Brown and Caldwell). More detailed information can be obtained from the BMP report. The principal biosolids treatment technologies to be used include thermophilic anaerobic digestion; co-digestion with other organic substrates such as fats, oils, and grease (FOG) and food waste to increase biomethane production; thermal drying to produce a biosolids product for beneficial reuse; gas scrubbing to produce pipeline quality biomethane fuel; and phosphorus recovery from dewatering centrate to produce a saleable fertilizer. The representative technologies selected for the biosolids treatment process are shown schematically in **Figure 4.1**.

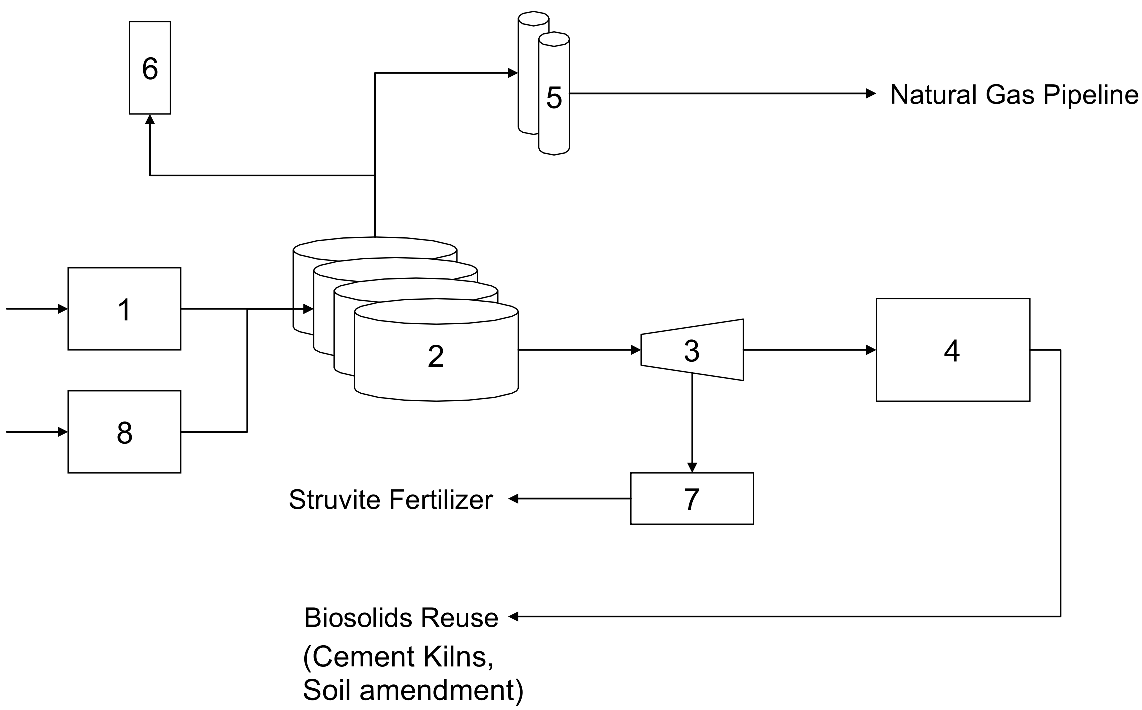

Figure 4.1 – Biosolids Treatment and Resource Recovery

1. Screening – Co-thickened primary and secondary sludge is screened to remove visible foreign material.
2. Thermophilic anaerobic digestion – Anaerobic digestion of thickened solids at thermophilic temperatures to reduce solids and pathogens and enhance production of usable biogas. This technology is capable of producing a Class A biosolid. Co-digestion of FOG and food wastes is included in the design.
3. Dewatering – Dewatering of digested biosolids through centrifugation.
4. Thermal drying – Removal of moisture from biosolids with a belt dryer and produce a product that can be used as a fuel or fertilizer.
5. Gas Scrubbing – Digester biogas would be cleaned and scrubbed to pipeline quality and sold to the local gas utility.
6. Flare – Complete combustion of any waste gas streams.
7. Nutrient Recovery – A nutrient recovery process would precipitate out struvite from the centrate. Struvite can be sold as a fertilizer product.
8. Organic Waste Receiving – Certain organic wastes from solid waste streams such as food wastes, FOG, commercial or industrial sources would be screened and added to the digestion process to increase digester gas production.

4.2 Integration of Biosolids and Solid Wastes

There are several opportunities for integration of biosolids with solid waste processing and disposal. The integration of appropriate organic wastes at the biosolids facility can increase biogas production and energy recovery from the digestion process while reducing the volume of wastes sent to the regional landfill. The CRD has a proposed organics ban date of May 2012 disposed to the landfill, and the current Solids Waste Strategic Plan has a short term goal of 60 percent diversion of organic wastes from the landfill by 2013 and 90 percent diversion by 2020. To support these goals, it is proposed that CRD implements co-digestion as part of its standard operating procedure for wastewater solids processing and handling at the new wastewater treatment facilities for CRD. Combining fats, oils and grease or "FOG" (including brown grease and some yellow grease) with wastewater solids loaded to the digester will greatly increase biogas production. The biosolids facilities are capable of receiving FOG and other organic wastes at an organic waste receiving station. A screening process at the organic waste receiving facility will ensure organic wastes added to the biosolids treatment process do not contribute any undesirable inert material to the final biosolids process.

The biosolids facilities have been configured and sized to be capable of receiving a significant fraction of available organic wastes from the community. This includes an additional 10 percent volume of anaerobic digester tankage for organic waste substrate addition, and adequate capacity for receiving the majority of FOG in the CRD. Additional biogas production, beyond FOG addition, could be achieved through the addition of some food wastes from residential and commercial sources and/or liquid organic wastes from other industries in the region. The addition of food wastes to the biosolids digesters that require minimal processing would further reduce the organics load to the landfill, where currently food wastes contribute approximately 20 percent of the material entering CRD's landfill. Additional receiving and processing considerations are required to integrate food waste with biosolids processing. Contaminants such as broken glass and eating utensils must be carefully removed, for example, and the separated food waste solids must be slurried or pulped prior to digestion. These provisions add complexity, space requirements and cost to a wastewater treatment plant solids processing facilities.

Another possible integration option is combining dried biosolids with combustible solid waste in a regional waste-to-energy facility. Drying is included in the representative biosolids processing facilities evaluated in this report. However, the assumption is made that the dried product is used as cement kiln fuel. Feasibility of a regional waste-to-energy facility is being evaluated independently by the CRD and other potential participating agencies.

Co-locating biosolids processing facilities at the Hartland Road landfill provides significant opportunities for solid waste / biosolids integration. This could enhance co-digestion and open up alternatives such as landfill biocells, combining digested sludge with solid waste in a specially designed landfill cell to enhance gas production. Future waste to energy and soil amendment facilities could also be located at the Hartland landfill.

4.3 Site Constraints

Although there are numerous criteria that influence the acceptability of a site for biosolids facilities, the principal site constraint is availability of adequate room for all required processes. At the McLoughlin site for Option 1A, little land is available for co-location of biosolids facilities. Preliminary site layouts indicate adequate space is available for the required liquid treatment facilities, but space for a complete biosolids facility is unavailable unless additional land is purchased. For this report it is assumed that the biosolids treatment facilities will be located at the CRD operated Hartland landfill. This site has sufficient space to construct biosolids facilities. A pipeline and four lift stations are required to pump the thickened sludge to the proposed biosolids treatment complex located at the Hartland landfill.

4.4 Regional Energy Centre (Biosolids) Facility

The concept of a regional biosolids processing facility involves all processing of biosolids for the entire region at a single site. A regional biosolids facility would provide wastewater solids stabilization and allow for integration of organic solid wastes by siting separate digesters in the same location. For this project it is assumed the biosolids treatment facility will be located at Hartland landfill. Regionalization of the biosolids facility could improve economy of scale provided by larger processing facilities and the efficiency of centralized resource recovery.

4.5 Resource Recovery from Biosolids Processing

Resources recovered from solids processing could include biogas, a soil amendment product, and a dried fuel product. The biogas produced from digestion would be scrubbed to natural gas quality and sold to the local natural gas utility. This approach provides significant GHG offsets. The soil amendment product would have a variety of potential beneficial uses, such as a blended topsoil fertilizer product for sale to the local communities, and as a biocell additive to enhance organic waste destruction and energy recovery at the landfill. Also, dried biosolids can be sold as a fuel to industries burning solid fuel, such as cement kilns, paper mills, and energy facilities. The Biosolids Management Plan (Nov. 2009) estimated that up to 90% of biosolids could be disposed of in cement kilns.

A more detailed explanation of biosolids resource recovery processing and utilization is included in Section 6.0.

4.6 Description of Solids Treatment for Option 1A

Under Option 1A, the solids treatment facilities are consolidated at Hartland landfill. Solids processes would include thermophilic anaerobic digestion, thermal drying, biogas scrubbing to pipeline quality, and integration of FOG waste to enhance gas production.

Section 5 Conveyance Systems

5.1 Description of Existing Conveyance System

The existing CRD sewage collection system consists of two major catchment areas: Clover Point and Macaulay Point. The Northeast Trunk system drains to Clover Point and the Northwest Trunk system drains to Macaulay Point. The system utilizes several wastewater trunk mains to convey sewage through several municipalities and discharge to Clover Point and Macaulay Point pump stations, where the sewage is screened and discharged to the outfalls. The existing conveyance system is shown in **Figure 5.1**.

5.1.1 Clover Point Pump Station and Outfall

The East Coast Interceptor trunk main intercepts the Saanich Municipal trunk main, the Victoria City trunk main, and the Northeast trunk main at the Victoria Municipal Boundary prior to discharging to Clover Point pump station. The Clover Point service area includes several bypasses or overflow sewers located at Finnerty Cove, McMicking Point, Rutland Pump Station, Humber Pump Station, Harling Point Lift Station and Broom Road overflow. These bypasses or overflow sewers were designed to release the excess flow during extreme storm events.

The existing screens at Clover Point pump station screens solids greater than 6 mm and the solids are collected for transport to the landfill. The 1050mm diameter outfall extends 1154 m into the ocean at an average depth of 67m and terminates with a 196 m long diffuser. A 330 m emergency bypass outfall allows flows exceeding 4 x ADWF to be discharged to the outfall.

5.1.2 Macaulay Point Pump Station and Outfall

Several trunk sewers are serviced by the Macaulay Point Pump Station and Outfall. The Esquimalt/Western Communities trunk sewer collects flow from the municipalities of Colwood, Langford, View Royal and Esquimalt, and pumps the wastewater to Macaulay Point through the pump stations located at Lang Cove and Craigflower. The Northwest trunk main convey sewage from four Saanich Municipal subtrunk mains to Macaulay Point. The subtrunk mains collect sewage from North and West Saanich areas. A pump station located at Marigold lifts the sewage from the three northern Saanich subtrunk mains to the Northwest Trunk main, while a pump station located at Gorge Road pumps the sewage to Macaulay Point pump station and outfall.

The Macaulay Point outfall screens solids, plastics and floatable material larger than 6mm; the solids are transported to the landfill approximately twice weekly. The outfall extends 1.7km into the ocean at a depth of 60 m. The 1050 mm diameter outfall has a diffuser 150 m long with 28 ports.

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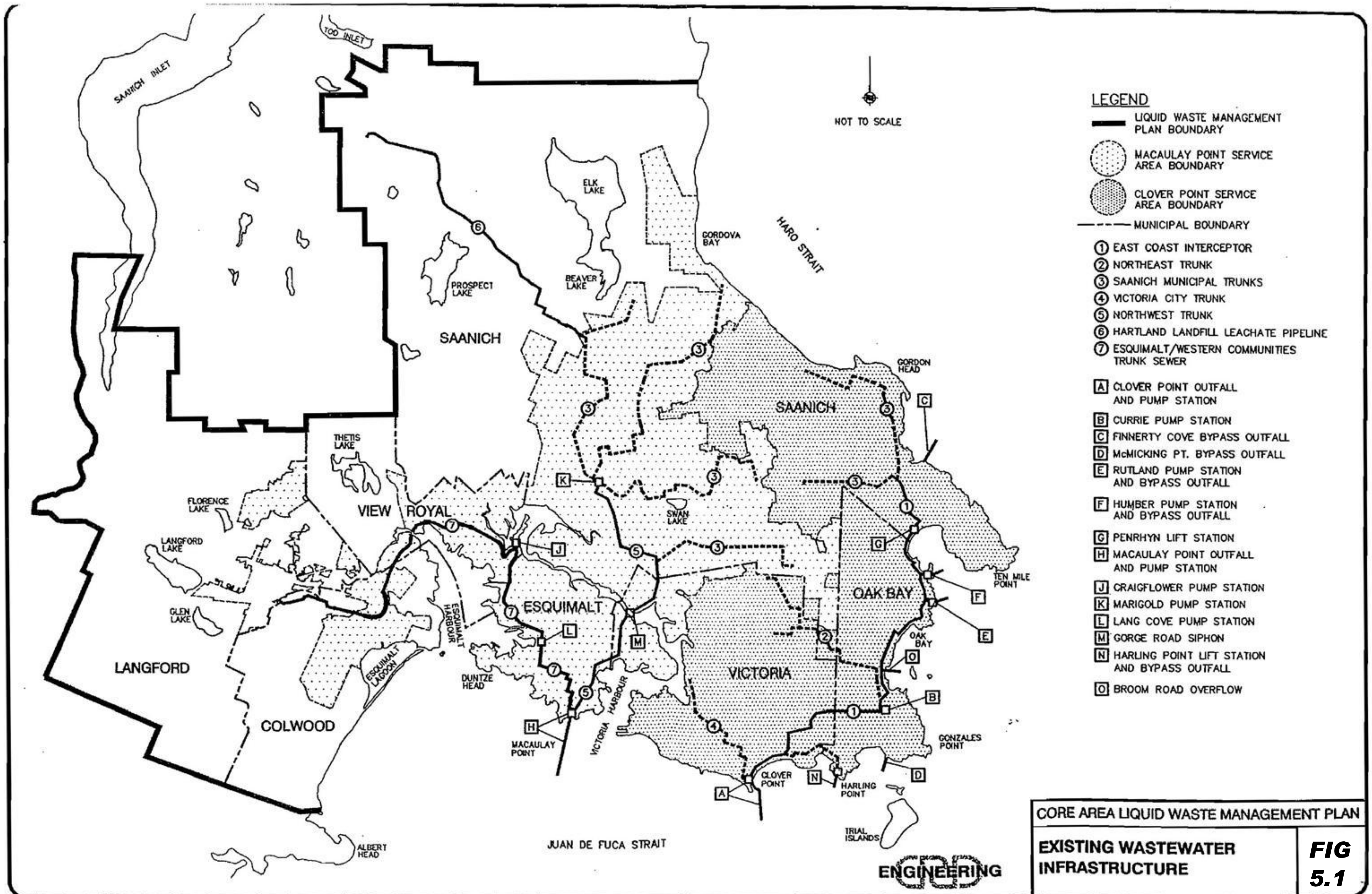


CORE AREA LIQUID WASTE MANAGEMENT PLAN

EXISTING WASTEWATER INFRASTRUCTURE

FIG 5.1

5.2 Conveyance System Upgrading Requirements

The proposed CRD wastewater treatment options will require modifications of the existing conveyance system. The existing two sewage catchment areas will be converted to four catchment areas, namely East Saanich, Clover Point, Macaulay/McLoughlin Point, and West Shore, for servicing by the proposed wastewater treatment facilities or pumping stations located in the corresponding area.

5.3 Option 1A - Conveyance System

Option 1A system is composed of a secondary treatment plant for the Saanich East – North Oak Bay area, a wet weather station at Clover Point with a pump station transferring flow to McLoughlin Point secondary wastewater treatment plant, a Macaulay Point pump station, as well as a new secondary wastewater treatment plant for the West Shore.

5.3.1 Saanich East - North Oak Bay WWTP

Wastewater from the Saanich Municipal trunk sewer in the Saanich East - North Oak Bay region will be redirected towards the Saanich East - North Oak Bay treatment plant. The proposed treatment plant will provide primary treatment for up to four times the average dry weather flow (ADWF) and of that, only 1.75 times ADWF will undergo secondary treatment. Any flow over four times the ADWF will bypass the system and will be discharged to the outfall; any flow over 1.75 times ADWF after primary treatment will also be discharged to the outfall. Flow greater than four times ADWF is generally high flow wet weather runoff. The Saanich East treatment plant will send biosolids from the treatment process into the East Coast Interceptor system to Clover Point where they will be pumped to the McLoughlin plant.

5.3.2 Clover Point WWTP and Pump Station

In Option 1A the proposed Clover Point treatment plant will be a high rate wet weather plant which only operates periodically. Flow from the East Coast Interceptor, Northeast trunk and Victoria City trunk mains will be intercepted at Clover Point. All incoming flow will be screened utilizing existing 6 mm screens; flow up to two times ADWF will be pumped to McLoughlin WWTP for secondary treatment. The forcemain will be 900 mm in diameter and 4.6 km long. It will run along Dallas Road to Ogden Point, before it enters a tunnel in order to cross Victoria Harbour. Flow between two and four times ADWF will be treated in a new wet weather plant at Clover Point prior to discharging to the outfall. Flow above four times ADWF will bypass treatment and discharge after screening into the outfall for discharging into the Straights of Juan de Fuca.

5.3.3 Macaulay and McLoughlin Point WWTP

Flow from the Saanich Municipal trunk, Northwest trunk and the Esquimalt portion of the Esquimalt/Western Communities trunk main will be intercepted at Macaulay and McLoughlin WWTP. Flow in excess of four times the ADWF will bypass treatment and discharge out the

Macaulay Point outfall. Flows at four times or less than the ADWF will be sent to the new McLoughlin WWTP and will join the flow that was pumped from Clover Point and undergo primary treatment. Biosolids collected at the McLoughlin WWTP will be pumped to the new biosolids treatment facility at Hartland landfill.

5.3.4 West Shore WWTP

The West Shore WWTP will accept flow from Langford and Colwood. Flows entering the plant in excess of four times ADWF will bypass the treatment process and be discharged to a new outfall. Flows equal to or less than four times ADWF will go through the primary treatment process and of this flow, two times or less the ADWF will undergo secondary treatment prior to discharge through the new West Shore outfall. Sludge collected after primary and secondary treatment will be discharged to trunk sewer for the treatment of the Hartland, BC.

5.4 Marine Pipeline Crossing

Marine pipeline crossings at Victoria Harbour will need to be evaluated as several options may be present, but along with each option there are several risk factors. Option 1A will require a pipeline passage through Victoria Harbour from Clover Point to McLoughlin and Macaulay Point.

Options reviewed for the Harbour crossings include sinking and laying the pipe on the sea bottom and installing concrete mattresses on top or alternatively routing the pipeline around the harbour shoreline to stay clear of the traffic zones. The most feasible option reviewed is to tunnel under the harbours.

Several concerns that may be present for laying the pipeline on the seafloor are distance, marine traffic, underwater archaeological features and marine life. Large ships, such as the Coho present additional concerns to installing the pipe on the seabed. If large ships lose power while entering the harbour their emergency plan is to typically drop anchor. This poses an immediate threat to the pipeline if the anchor drags or lands on the pipe. Due to the nature of the pipe location and amount of flow passing through the pipes it is recommended that this risk be eliminated by tunneling under the harbour rather than laying pipe on the harbour seabed.

5.5 Outfalls

The CRD operates two sewage outfalls and several overflow outfalls as briefly described in section 5.1 and upgrades are required as described in Section 5.2. Preferable pipe material is HDPE for the Saanich East - North Oak Bay, Macaulay Point and West Shore outfalls. HDPE is not available in sizes over 1800mm diameter; therefore, the West Shore outfall will need to be epoxy coated steel pipe or consideration for two smaller pipes in HDPE material can be reviewed. HDPE is a preferable pipe material for outfalls because it is durable and can withstand large loads. As well HDPE pipe is relatively simple to float and sink into place during installation and does not require specific bedding material. If alternate pipe material other than HDPE is to be used then investigation into seabed conditions will need to be conducted.

Installation of the outfalls will require trenching and excavation of the inter-tidal beach section. Excavation and burial of the pipe will require an excavator working the tides from the beach and the pipe is to be covered with native materials. HDPE pipes will be weighted with conventional concrete ballasting (cylindrical or block shaped) weights for the float and sink procedure. Additional weighting of the pipe with concrete mattresses may be required to further protect the installed pipeline from wave and ocean currents.

Depth of pipe installation will directly affect the risk factors and costs during construction. Depths below 50 m are standard and can be conducted with regular diving procedures. Depths greater than 50 m lead to expensive mixed gas diving and increased risk factors. The Macaulay Point outfall is currently at a depth of 60m. The new Finnerty Cove outfall and West Shore outfall may possibly be installed at a depth of 50 m or less, but will depend on ocean tides and seabed conditions.

Additional items to consider for outfall installation that are difficult to allow for are location details specific to site conditions, towing distance from joining site to installation site, wind, waves, tidal levels, alignment accuracy, vessel traffic in area (boats running over pipe) and project timing. Macaulay Point and the West Shore are located within busy shoreline areas (near the harbour or the Royal Road and direct pathways around the island) and it can be expected that ship traffic will have to be redirected while carrying out the float and sink method. Ship moorage/anchorage may also pose future risks if anchors graze the installed pipeline; therefore, concrete mattresses would be recommended in areas where ships anchor.

New outfall requirements include a new 900 mm outfall paralleling the existing outfall at Finnerty Cove, a new 1500 mm parallel outfall at MaCaulay Point, and a 1500 mm outfall serving the West Shore plant.

5.6 Pumping Facilities

As part of the overall plan, major pumping facilities will be required. This section summarizes the facilities necessary for the project.

5.6.1 Saanich East - North Oak Bay Pump Station

A new pump station with two submersible pumps will be built for the SENOB WWTP to lift raw sewage to the new headworks. The following design criteria have been developed for preliminary sizing of the facility.

- Firm pumping capacity (excluding standby pump): 68.7 ML/D for all options.
- Static lift: 8 m
- Approximate total dynamic head: 9.5 m
- Station discharge pipe size: 750 mm

- Approximate length of discharge line: 15 m
- Number of pumps to be installed: 2 (1 duty + 1 standby)
- Each pump capacity: 68.7 MLD
- Type of pump: Submersible solids handling centrifugal pump
- Preliminary pump selection: Flygt C3531, 135 HP
- Grinder: CDD4020-XD2.0 (Channel Monster)

The submersible pumps have been selected for cost effectiveness in capital and operating costs for the intended low lift service as compared with conventional dry-pit pumps. The pump station will be built with equipment (pump) access hatches open to the outdoor atmosphere with no superstructure above the wetwell. A portable truck crane would be used to remove the pump for servicing.

A grinder will be installed in a separate chamber immediately upstream of the pump station inlet. The grinder is intended to reduce the size of solids to prevent the pump from clogging.

5.6.2 Clover Point Pump Station

In Option 1 A the Clover Point Pump Station will pump up to 2xADWF to Macaulay / McLoughlin WWTP, while the wet weather high flow would be bypassed to Actiflo for primary treatment prior to discharging to the ocean outfall. For the purpose of preliminary engineering, it is assumed that the existing station can be upgraded to meet the flow demand for Options 1A. Currently, the existing station is equipped with four vertical sewage pumps of 250 HP each with extended drive shafts connected to motors mounted on the top operating floor.

The existing station is also equipped with mechanical screens, which are adequately sized to serve the future CRD flows.

Under Option 1A the upgrading requirement would include replacing two of the four pumps, while the remaining two units would be utilized for wet weather flow bypass pumping to the ocean outfall. The existing station piping would be modified to separate the two pumping functions: one for bypass pumping to the ocean outfall and the other for pumping to McLoughlin WWTP.

The following design criteria have been developed for preliminary sizing of the facility.

5.6.2.1 Options 1A – Clover Point Pump Station Upgrade

- Firm pumping capacity (excluding standby pump): 75.6 ML/d
- Static lift: -9 m (downhill pumping - backpressure sustaining valve required to keep the forcemain full and prevent pump runout)
- Approximate total dynamic head: 13 m
- Station discharge and forcemain pipe size: 900 mm
- Approximate length of discharge line (forcemain): 5100 m
- Number of pumps to be installed: 2 (1 duty + 1 standby)
- Each pump capacity: 75.6 ML/d
- Type of pump: Vertical sewage pump (similar to the existing)
- Preliminary pump size: 200 HP (based on Flowserve Model 24MN28C)
- The remaining two existing pumps would be kept for bypass pumping duty.

5.6.3 Macaulay Pump Station

The proposed Macaulay Pump Station is designed to pump the influent sewage to the McLoughlin WWTP.

The existing pump station is considered not fit for upgrading to handle the required flow in all options; therefore, a new pump station will be built. For the purpose of preliminary engineering, it is assumed that the new pump station would be designed in similar configuration to the existing station that has separate wetwell and drywell compartments. All pumps would be installed in the drywell with motors located on the top main floor. A traveling crane would be provided in each station to handle the pump and motor equipment.

The following design criteria have been developed for preliminary sizing of the pumping facility.

5.6.3.1 Option 1A (Pumping to McLoughlin)

- Firm pumping capacity (excluding standby pump): 276 ML/d
- Static lift: 15.5 m
- Approximate total dynamic head: 18 m
- Station discharge pipe and forcemain size: 1800 mm
- Approximate length of discharge line (forcemain): 1000 m

- Number of pumps to be installed: 3 (2 duty + 1 standby)
- Each pump capacity: 138 ML/d
- Type of pump: Vertical sewage pump (similar to the existing)
- Preliminary pump size: 500 HP (based on Flowserve Model 30MN33C)

The existing pump station would be kept for emergency bypass pumping duty.

5.6.4 Pump Station Control

The pumps will be run by VFD's to adjust the pump output to closely match the influent while maintaining the self cleansing velocity in the discharge forcemain system. Advantages of VFD would also include smaller active wetwell volume (i.e. lower wetwell structural cost), lower pump starting (locked rotor) current, and reduced hydraulic upsurge during normal pump starting and stopping sequences.

The pumps will be controlled on the basis of sewage level in the wetwell measured by an ultrasonic level controller backed up with float switches for high and low level alarms. The pump station operating status including alarms will be centrally monitored.

5.7 Sludge Conveyance

The sludge conveyance system will transport sludge from the McLoughlin wastewater treatment plant to the Harland Landfill for treatment. A 17.7 km – 200 mm pipeline and four pumping stations are required to transport sludge from McLoughlin Point to the proposed biosolid facilities which will be located at Hartland landfill. The 180 metres of static head requires the use of multiple pump stations in series to lift sludge to the proposed biosolids treatment facilities at Hartland landfill.

5.8 Tunnel Design Concept

Option 1A requires a tunnel of approximately 0.9 kilometers from the Ogden Point shipyard area to the new treatment plant at McLoughlin Point.

Options for crossing the harbour include a horizontal directional drill (HDD) or an "utilidor" style conventional tunnel. The HDD method will include two forcemains across the harbour using HDD techniques. HDD allows for installation of energy and municipal piping with limited impact to the surrounding area caused by construction. Installation time is estimated at 6 months for pipes using HDD method.

The conventional tunnel or "utilidor" will allow personnel passage through the tunnel, and would enable installation of several pipes inside the utilidor and allow addition of piping in the future if necessary. A minimum 3 metre utilidor tunnel would be viable to service the CRD sewage system. The conventional tunnel requires a tunnel boring machine (TBM). Installation time is approximated at 10 m per construction shift. The utilidor tunnel will require lighting and ventilation. Portal shafts will be required at either ends of the tunnel for access. A 6m diameter shaft shall be sufficient for access and shaft depths may exceed 35m depending on the quality of soil/bedrock. Investigations into soil and bedrock structure and feasibility of tunneling through the structure will need to be completed. Depth of the tunnel below the sea bottom should be investigated; a preliminary estimated suggestion would be to drill the tunnel at least five tunnel diameters between the bottom of the harbour and the top of the tunnel. Additional investigations should include risk assessment, environmental impact assessments, earthquake impact assessment and an archaeological impact assessment for both land and underwater at a minimum.

The final harbour crossing methodology will be determined following geotechnical investigation. For the purpose of cost estimates, conventional tunneling is assumed.

Section 6 Resources from Wastewater

6.1 Water Reuse

6.1.1 Water Reuse

Wastewater effluent reuse is becoming more common in North America. In arid climates such as California and Arizona, it has been practiced for years. For CRD all of the secondary treatment plants in this option will include tertiary membrane filtration for at least a portion of the plant flow. The final size of reuse facilities will be confirmed once market analysis is completed. For **Saanich East - North Oak Bay WWTP** the University of Victoria grounds and surrounding parklands are the identified markets for irrigated water in the near term since effluent pipelines will be established there to provide extracted heat for UVic. There are several golf courses within a reasonable distance from the plant e.g. Cordova Bay, Cedar Hill, Uplands which could become customers.

For **McLoughlin Point WWTP** there could be a market for high quality irrigation water on some of the parade grounds, PMQ residences and military building grassed areas adjacent to the plant. A major potential for effluent reuse from this plant would be the Provincial Legislative grounds and surrounding municipal parks en route along the waste sludge line to the biosolids management area at the Hartland landfill site and the extracted heat pipelines planned to serve harbourside hotels and the Parliament buildings.

For the **West Shore WWTP** there would be a market for limited irrigation use on the plant grounds but there is an additional potential market to irrigate the surrounding land development for which this planning phase has targeted for heat extraction for about 1000 residences by 2030. Servicing long term green community development for 10,000 residences is not out of the question for the West Shore plant. Potential golf course customers could be Olympic View, Metchosin and Royal Colwood. The Royal Roads University grounds are also a potential customer for irrigation water.

6.2 Heat Recovery

The waste water treatment plants will require a large amount of heat for the digesters, biosolids, drying and space heating. Heat recovery at the biosolids facilities would include recovery of heat from the hot digested sludge using sludge-to-water-to-sludge heat exchangers. The heat recovery system will minimize heating requirements of the raw sludge being fed to the digesters. The heat recovery system will recover approximately 50% of the heat required to heat the digestion system.

Additional plant heat demands would be provided by heat extraction from the effluent. A hot water heating loop will provide the heat required for each of these loads. Electrically powered heat pumps will supply heat to the hot water loop by using the available heat in the effluent discharged from the treatment plants. The heating of the digesters will be provided from the hot water heat loop, and the use of heat pumps will allow the use of biogas exclusively for biomethane under normal operating conditions. If electrical power supply to the plant is lost, the backup diesel generator will be able to provide enough power to the heat pumps to continue to heat the digesters. A biogas boiler rated at partial heat load will also act as a back up to the heat pumps.

Heat recovery will be accomplished by water source heat pumps extracting heat from treated effluent. Instead of exhausting into the ocean, the heat will be reclaimed. The heat pumps will supply approximately 70º C (160 deg F) water to the closed loop system. This temperature aligns with the temperatures required for the sludge plant processes and suited to building boiler temperatures and temperatures needed to generate domestic hot water. New heat pumps recently developed in Europe are now capable of producing product water of about 90º C (200º F), but are not as yet available for sale in North America due to electrical code listing requirements. We anticipate that by the time this project is implemented these units will be available in North America.

Focus has been placed on delivering heat to high demand areas and areas of future growth and development where a district heating system would have the most potential for success. These neighborhoods typically encompass government and commercial buildings, industry, health care and education which house boilers and/or existing district heating systems.

At an incentive price estimate of $10/GJ, annual revenue from the sale of heat generated from effluent could top $9 million dollars by 2065. Annual costs to generate the heat and maintenance are estimated at approximately $5.6 million leaving annual earnings from heat reclaim sales of approximately $3.4 million in 2065 assuming there is a market for the captured heat. A realistic target may be 50% of the heat developed could be sold. Further market analysis may need to be conducted in the area of “incentive price”. Also affecting earnings from heat sales would be recent advances in the coefficient of performance of heat pumps and chiller systems. This could have significant effect on returns.

It is noted that studies are under way to assess the demand for reclaimed water and heat in the UVic and James Bay areas.

6.2.1 Saanich East - North Oak Bay Plant

This facility, in the initial design, could supply heat to the University of Victoria. Heated water could be transferred approximately 3.5 km (7km return loop) to the University’s existing district heating plant.

6.2.2 McLoughlin Plant

Heated water from the McLoughlin plant will provide heat to larger commercial buildings in James Bay and the downtown core. As well, the biosolids plant will be provided with heated water for their processes. The biosolids plant commands approximately 10% of the total heat available from the effluent flow at McLoughlin. The return distance of the heat pump loop is approximately 10 km. Economic advantages of conveying the sludge pipe and heating pipes in the same trench will be maximized.

Under Option 1A, supplying heat to the downtown core of Victoria, the entire heat capacity from the effluent of this 87.5 ML/d (ADWF) plant in 2065 could be sold if there is a market for this heat. The saleable heat of 588,000 GJ/yr could be sold to a third party for $5,880,000 in 2065 assuming all heat is sold. It is likely more realistic to assume only 50 – 65% could be sold due to market conditions. Detailed assessment of this option is currently being investigated.

6.2.3 West Shore Plant

Demand was considered for the Royal Bay area only. This was due to long distances to other high demand areas on the West Shore such as the growing commercial areas in Langford. The demand in the Royal Bay zone will come from new developments wishing to take advantage of this "green" energy source. Conversion to district heating for new development areas is easier to accomplish than for neighbourhoods with established infrastructure. This is a significant development opportunity. The West Shore has the greatest potential for District Heat because new development could be specifically designed for implementation of District Heating.

Under Option 1A a total saleable heat of 257,000 GJ/day in the shoulder and winter seasons, $2,570,000 of sales could be generated by 2065.

6.2.4 Key Performance Indicator Summary

Potential net heat revenues could range from $2.7 to $3.2 million in the year 2030. This could increase if markets are available. Annual expenses for generating the heat and maintenance is approximately $4.5 million (a loss of $1.3 million annually). These revenues will fluctuate depending on the available market.

If a more reasonable unit price of $14 per GJ could be achieved, revenue from heat generated could be increased. Again market analysis would need to be conducted in this area to determine an "incentive price". It is noted that only a certain percentage of the heat will likely be sold as it is unlikely that 100% sales could be obtained. Further work on the market for this heat should be completed.

In any event heat recovery for in plant use is highly feasible based on experience at other facilities.

6.3 Gas Recovery

The biogas produced by the digesters will be upgraded through the gas scrubbing system to high quality biomethane and injected into the natural gas pipeline. The biogas upgrading process has multiple stages of compression and purification. Hydrogen sulfide and bulk water are removed at the beginning of the process at low pressure. A scavenging media will remove hydrogen sulfide. The sweetened biogas is then compressed and run through a two stage Pressure Swing Adsorption (PSA) system to remove carbon dioxide, water and other impurities (e.g. siloxanes). The second stage PSA system upgrades the waste gas of the first stage PSA system to recover approximately 95% of the methane, and the combined process produces a fuel with an energy value equivalent to natural gas. A schematic of the biogas scrubbing system is shown in **Figure 6.1**.

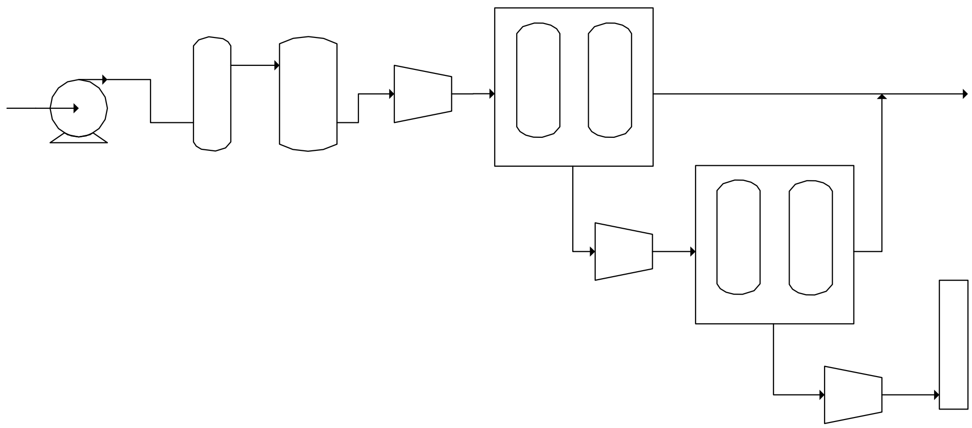


Figure 6.1
Biogas Scrubbing System Schematic

6.4 Phosphorus Recovery

Phosphorus is released as volatile solids are destroyed in the anaerobic digestion process (mesophilic and thermophilic). The released phosphorus is typically recycled to the liquid stream process for removal but can be recovered for beneficial reuse. Phosphorus is a non-renewable, irreplaceable resource (and as the elemental basis essential for all life forms) phosphates are a vital compound to key on for sustainable development, and for this main reason, good environmental stewardship suggests that phosphate should be recovered from waste streams for recycling, rather than continued mining of the existing (and now increasingly more low grade) and depleting phosphate rock. Phosphorus recovery from wastewater recycle streams offers an additional benefit of offsetting carbon dioxide equivalent emissions relative to conventional fertilizer manufacturing (CO_2 emissions associated with phosphate rock mining and transportation to market).

The consulting team assessed the potential for phosphorus recovery from anaerobic digester return streams using struvite crystallizers as part of the evaluation. Our initial evaluation indicates that CRD should be able to recover approximately 272 tonnes of struvite fertilizer product per year from anaerobic digester return streams. The net revenue (sales revenue minus annual operating and maintenance costs) from phosphorus recovery via struvite crystallization is estimated at approximately $54,000/year. The environmental benefits of phosphorus recovery will include the offset of approximately 2,700 tonnes of carbon dioxide equivalent emissions per year relative to conventional fertilizer manufacturing.

6.5 Biosolids Resources

The Biosolids program will maximize resource recovery and utilization while marketing diversely to provide reliability and redundancy. Diverse markets will also stimulate product demand and revenue recovery. For evaluating GHG impacts and benefits and revenues the following Biosolids markets allocations have been assumed:

- 50%-90% Thermally dried biosolids for sale as fuel to cement kiln, pulp mill or private waste to energy facility.
- Sale as dried fertilizer product.
- Preparation and sale of a blended soil amendment.
- Application to mines or other degraded lands for reclamation.

6.5.1 Dried Fuel Product

Energy recovery is a productive end use option for biosolids. In cement manufacturing, the biosolids are burned as fuel and the ash is used for raw material substitutes. The heating value of dried biosolids is typically 18,000 kJ/kg. This is only slightly lower than soft coal, which typically have a heating value of 26,000 kJ/kg (Forgie et al, 2008). Dried biosolids fuel products provide an alternative renewable energy source to fossil fuels such as coal. The noncombustible components of solids can provide the chemical components (CaO, SiO2, Al2O3, and Fe2O3) which are traditionally supplied by lime, clay and iron ore. The replacement of these materials can offset transportation costs of bringing these raw materials to the cement plant. Other industries such as paper mills and waste to energy facilities can also benefit from using a dried biosolids product as fuel.

6.5.2 Top Soil Amendment

Class A Biosolids can be utilized as an ingredient in manufacturing topsoil. The CRD currently has their own soil amendment called Pengrow and this demand for this product has been good. Similar products produced in the Okanagan at Kelowna and Penticton have been very successful. Another notable example is the City of Tacoma, which mixes biosolids with sawdust and sand to make "TAGRO" (http://www.cityoftacoma.org/Page.aspx?hid=688). TAGRO has been used successfully in the local community for nearly 20 years. Biosolids topsoil products like TAGRO improve soils similarly to finished compost. These products are not marketed as fertilizers, but rather are soil amendments which improve tilth, infiltration, water holding capacity, and general productivity. On depleted soils or in areas where topsoil has been disturbed such products can be particularly valuable. Notable examples include new construction, highway medians, and landscaping projects. Biosolids and topsoil products also have a highly successful record in reclamation projects on disturbed land like mine tailings and landfill cover. Metro Vancouver's "Nutrifor" program (http://www.metrovancouver.org/services/wastewater /nutrifor/Pages /default.aspx) provides many documented examples. The goal for all of these programs is to boost soil organic matter to levels comparable to productive soil (approximately 3-5% in the top 15 cm). While organic matter is a primary component of alluvial soils in river valleys, it is lacking many other areas. Soil amendments can correct this condition and provide long-lasting improvement to plant growth.

6.5.3 Biocell

A biocell is an innovative closed loop landfill reactor system that is operated in two stages where biosolids are mixed with municipal wastes and placed in a landfill with gas collection equipment. In the first stage, the bioreactor mimics an anaerobic digester to capture biogas released from decomposing biosolids mixed with solid wastes. The captured gas can then be converted to power. In the second stage, air is injected into the solid waste to promote an aerobic composting environment (Hettiaratchi et al 2007). After a period of time the compost can be removed from the biocell. A biocell is particularly beneficial in this design as a backup to receive any overflow solids when seasonal demand is low or if complications arise in the solids dryer. A biocell has been constructed and operated successfully at the City of Calgary.

Potential revenues from the biosolids stream are summarized in **Table 6.1**.

6.6 Biosolids Regional Energy Centre

As part of the wastewater planning for the CRD a separate biosolids management plan is being completed. This master plan will consider opportunities for integration of biosolids and solid waste activities within the CRD. Depending on the final location of biosolids treatment facilities there is an opportunity to develop a regional energy centre which would integrate biosolids and the organic fraction of solid wastes. This facility could accept fats, oil and grease to enhance digester gas production. Biomethane production could be used for fueling vehicles and sale to the gas transmission system. This concept will be further developed in the biosolids master plan.

Table 6.1
Biosolids Treatment Facility Potential Revenues

Revenue Stream	Unit	Option 1A Upper Victoria Harbour	Option 1A West Shore	Total Revenue
Biomethane Recovery				
Digester gas production [1]	m^3/day	16,900	4,100	21,000
Average biomethane produced [2]	N m^3/hr	320	80	400
Unit biomethane value [3]	$/GJ	$8.00	$8.00	$8.00
Potential revenue	***$/yr***	***$874,000***	***$218,000***	***$1,092,000***
Dried Fuel Product				
Digested biosolids produced	kg/day	13,400	3,300	16,700
Unit dry biosolids value [4,5]	$/GJ	$1.60	$1.60	$1.60
Potential revenue	***$/yr***	***$141,000***	***$35,000***	***$176,000***
Co-digestion Substrate Tipping Fees				
Average daily co-digestion substrate delivery [6]	L/day	55,200	13,800	69,000
Tipping rate [7]	$/L	$0.07	$0.07	$0.07
Number of trucks [8]	Trucks/day	8	2	10
Potential revenue [9]	***$/yr***	***$1,410,000***	***$353,000***	***$1,763,000***
Blended Soil Amendment Product				
Digested biosolids produced	kg/day	13,400	3,300	16,700
Digested biosolids produced [18]	m^3/day	22	6	28
Average blended soil amendment produced [10]	m^3/day	64	16	80
Average sale price of blended soil amendment [11]	$/$m^3$	$10.50	$10.50	$10.50
Potential revenue [12]	***$/yr***	***$246,000***	***$62,000***	***$308,000***
Compost				
Digested biosolids produced	kg/day	13,400	3,300	16,700
Digested biosolids produced [18]	m^3/day	22	6	28
Average compost produced [16]	m^3/day	67	17	84
Average sale price of compost [17]	$/$m^3$	$10.50	$10.50	$10.50
Potential Revenue	***$/yr***	***$257,000***	***$64,000***	***$321,000***
Biomass Production				
Willow coppice area	Ha	400	100	500
Usable willow coppice area	Ha	384	96	480
Energy Produced from biomass [20]	GJ/ha-yr	61.7	61.7	62
Usable energy produced from hybrid poplar [21]	GJ/yr	23,700	5,900	29,600
Potential revenue	***$/yr***	***$37,908***	***$9,477***	***$47,386***
Thermally Dried Product				
Digested biosolids produced	kg/day	13,400	3,300	16,700
Digested biosolids produced [18]	m^3/day	22	6	28
Average sale price of product [19]	$/$m^3$	$17.21	$17.21	$17.21
Potential revenue	***$/yr***	***$140,000***	***$35,000***	***$175,000***

Table 6.1
Biosolids Treatment Facility Potential Revenues

Revenue Stream	Unit	Option 1A Upper Victoria Harbour	Option 1A West Shore	Total Revenue
Raw Sludge Power Generation: Onsite Fluidized Bed Incinerator				
Raw biosolids	kg/day	24,700	6,000	30,700
Power produced [14]	MWh/day	14	4	18
Revenue [22]	***$/yr***	***$411,000***	***$103,000***	***$514,000***
Digested Sludge Power Generation: Onsite Fluidized Bed Incinerator				
Digested biosolids	kg/day	13,400	3,300	16,700
Power produced [14]	MWh/day	6	1	7
Revenue [22]	***$/yr***	***$164,000***	***$41,000***	***$205,000***
Raw Sludge Power Generation: Offsite Mass Burn Incinerator				
Raw biosolids	kg/day	24,700	6,000	30,700
Power produced [12]	MWh/day	32	8	40
Revenue [13]	***$/yr***	***$762,000***	***$185,000***	***$947,000***
Digested Sludge Power Generation: Offsite Mass Burn Incinerator				
Digested biosolids	kg/day	13,400	3,300	16,700
Power produced [15]	MWh/day	14	4	18
Revenue [13]	***$/yr***	***$339,000***	***$83,000***	***$442,000***

Notes:

1. Annual average gas production with co-digestion substrate addition, 30% by VS load.
2. Biomethane produced assumes 92.5% recovery of biogas CH_4 and 95% equipment availability to produce a final gas product of 98% CH_4 and 2% CO_2. Normalized at 0ºC and 1 atm. Biomethane recovery rate presented in Table 9.6 represents the biogas generated with four digesters in operation at the Upper Victoria Harbour site. For the WTE alternatives, only three digesters will be installed, and under this condition biomethane recovery will decrease by approximately 5%.
3. Terasen has expressed interest in a long-term contract for biomethane at $6 to $10 per GJ. An average of $8 per GJ is assumed here, but the revenue may be higher or lower based on final contract negotiations with Terasen. Higher heating value for 98% methane by volume is 38,971 kJ/Nm^3.
4. Price of biosolids fuel/wood fuel is based on 80% of average cost of equivalent coal energy ($2.00/GJ). Price for coal energy is based on $53.09/tonne and 26.7 MJ/kg (U.S. DOE).
5. Higher heating value of dried biosolids, 18,000 kJ/kg.
6. Excess capacity in digester is assumed to be used to accept FOG, assuming approximately 80% capture of FOG available in CRD.
7. Tipping fee is assumed equal to septage receiving tipping fee at Metro Vancouver's Iona Island WWTP.
8. Co-digestion substrate truck volume assumed is 10 m^3 and truck number calculated assuming trucks deliver co-digestion substrate at 3/4 of capacity (7.5 m^3/truck).
9. Revenue for accepting co-digestion substrate assumes receiving substrate 365 days per year.
10. Blended soil amendment product consists of 2:2:1 dried biosolids, sawdust, and sand, respectively.
11. Sale price for blended soil amendment product assumes same blend and price as TAGRO at $10.50/$m^3$, produced by the Central Treatment Plant, Tacoma, Wash.
12. Assumes dry raw sludge HHV of 22,000MJ/tonne and a plant heat rate of 16.9 MJ/kWh, which corresponds to an electrical power rate of 1,300 kWh/tonne

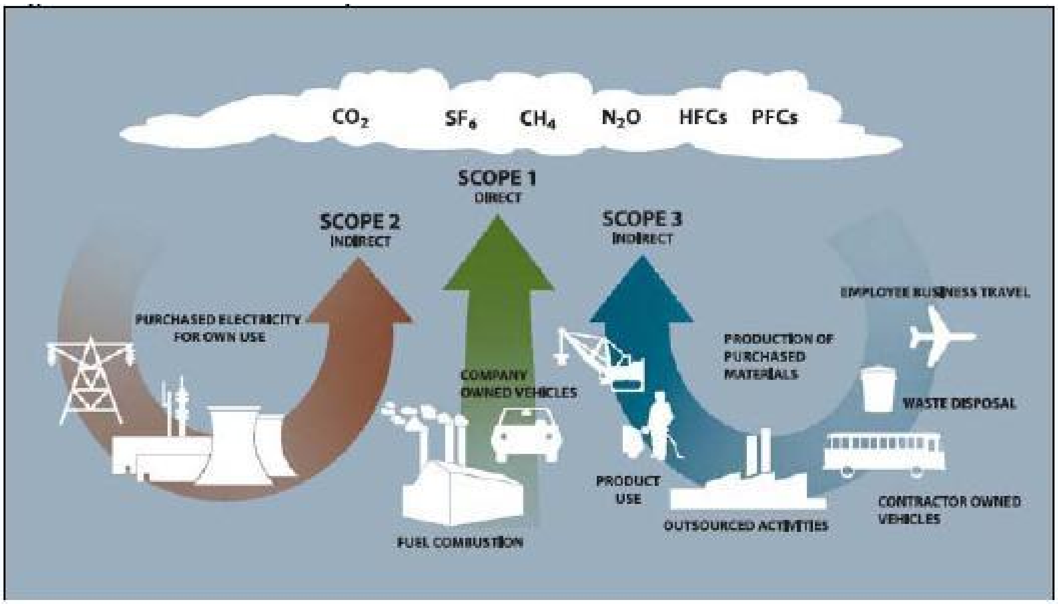
13. Assumes power rate of \$0.065/kWh. Values could range from \$0.03/kWh to \$0.12/kWh.
14. Based on internal modelling of fluid bed boiler with low pressure steam extraction for sludge drying. The HHV assumed for raw and digested sludge are 22,000 MJ/tonne and 18,000 MJ/tonne. Revenues are based on net power production (parasitic loads subtracted from gross power production).
15. Assumes dry digested sludge HHV of 18,000MJ/tonne and a plant heat rate of 16.9 MJ/kWh, which corresponds to an electrical power rate of 1,065 kWh/tonne.
16. Assumes compost comprises 2 parts sawdust to 1 part dried biosolids. Additional bulking agent from diverted yard waste can be used to offset sawdust requirements.
17. Price of compost is equivalent to price of blended soil amendment product.
18. Assumes bulk density of dry biosolids is 600 kg/m^3.
19. Assumes cost of fertilizer is equivalent to cost of dried product as fuel. In this case, \$17.21/m^3 is equivalent to 80% of average cost of equivalent coal energy (\$2.00/GJ). Price for coal energy is based on \$53.09/tonne and 26.7 MJ/kg (U.S. DOE). Biosolids are assumed to have a higher heating value of 18,000 kJ/kg.
20. Biomass energy production is based on a biosolids application rate of 12.79 dry tonne/ha, assuming N requirement of 200 kg/ha-yr and 15.6 kg/tonne of N is bioavailable.
21. Energy produced from biomass is 61.7 GJ/ha-yr, assuming energy produced from biomass is a net energy value that includes electrical and heat energy captured from burning.
22. Assumes power generated will be used onsite to offset power costs. Power cost savings are assumed to be \$0.08/kWh.

Section 7 Carbon Footprint Analysis

A carbon footprint analysis was performed as a part of the evaluation of the environmental impacts of selected Option 1A treatment strategy. A carbon footprint measures the amount of greenhouse gases (GHG) released or stored as a result of a process or activity. To separately account for direct and indirect emissions, GHG inventory protocols categorize direct and indirect emissions into “scopes” as follows:

- **Scope 1:** All direct GHG emissions (with the exception of direct CO2 emissions from biogenic sources).
- **Scope 2:** Indirect GHG emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling.
- **Scope 3:** All other indirect emissions not covered in Scope 2, such as emissions resulting from the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity (e.g., employee commuting), outsourced activities, waste disposal, etc.

This analysis included Scope 1, 2, and 3 emissions associated with the alternative design options. The emissions associated with the entire wastewater treatment process were evaluated (i.e., liquid stream treatment, solids processing and disposal and resource recovery) to the extent feasible at this preliminary design analysis stage. In addition, a limited analysis of the embodied emissions associated with the concrete and steel used in the construction of the new wastewater treatment facilities was also included. **Figure 7.1** illustrates the emission scope categories.



Source: WRI/WBCSD *GHG Protocol Corporate Standard*, Chapter 4 (2004).

Figure 7.1
Emission Scope Categories

7.1 Basis of Methodology

Carbon footprint analysis is a relatively new method of quantifying environmental impacts. Therefore, the analysis methodologies can vary widely. The major sources for this analysis include Associated Engineering (AE) report previously prepared for this project as well as relevant scientific literature. Where possible, consistency with the previous consultant's reports was maintained. However, the carbon footprint analysis was altered to comply with the new design criteria and assumptions.

The three GHGs relevant to wastewater treatment plant operation are carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). The direct and indirect emissions and offsets of these GHGs associated with the alternatives are included in the carbon footprint analysis.

- Carbon Dioxide: CO2 enters the atmosphere by burning carbonaceous substances such as fossil fuels (oil, natural gas, and coal), solid waste, and trees, and as a byproduct of chemical reactions (e.g., the manufacture of cement). CO2 is also removed from the atmosphere (or "sequestered") when it is absorbed by plants or stored in the soil as part of the biological carbon cycle.
- Methane: CH4 is emitted during the production and transport of coal, natural gas, and oil. CH4 is also produced from the anaerobic digestion of waste at wastewater treatment facilities, through livestock, and by the decay of organic waste in municipal solid waste landfills.

- Nitrous Oxide: N_2O is emitted by agricultural and industrial activities, combustion of fossil fuels and solid waste and secondary biological nutrient removal wastewater treatment processes.

In addition to the above three GHGs, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) are also GHGs regulated under the Kyoto Protocol. These GHGs are not expected to be emitted in significant quantities from the wastewater treatment process and estimates of emissions of these GHGs associated with the alternative design options are not currently available, therefore these GHGs are not included in the analysis.

Once greenhouse gases are emitted into the atmosphere, they absorb and re-radiate heat with varied levels of effectiveness. The global warming potential (GWP) quantifies the contribution of each gas over a specific time interval in terms of CO_2. The GWP of CO_2, by definition, is 1. The 100-year GWP values of CO_2, CH_4, and N_2O are shown below, based on the 2001 Intergovernmental Panel of Climate Change (IPCC) Third Assessment Report.

- CO_2 GWP = 1 equivalent kilogram of CO_2
- CH_4 GWP = 23 equivalent kilograms of CO_2
- N_2O GWP = 296 equivalent kilograms of CO_2

The results of this carbon footprint analysis are reported in equivalent tonnes of CO_2. A summary of the emissions factors used to calculate the GHG emissions associated with the alternatives is provided in Table 7-1. A list of guiding assumptions is also provided below.

Greenhouse gas emissions can occur from anthropogenic or biogenic sources. Anthropogenic emissions are produced by human activities that remove sequestered carbon from the earth's crust and release it to the atmosphere (e.g., through the burning of fossil fuels). Biogenic carbon occurs in plants and animals that intake and dispense of carbon cyclically. Biogenic sources do not increase the amount of greenhouse gases in the atmosphere, but merely represent the "natural" cycling of carbon. Therefore, emissions of biogenic CO_2 are generally not accounted for in greenhouse gas inventories for wastewater treatment. In fact, biogenic carbon sources can be considered an offset when utilized in place of an anthropogenic source (for example, when using biogas from a wastewater treatment process as a fuel source in place of natural gas).

The carbon footprint analysis was performed using estimates for the operation of the facilities in the design year of 2030. The construction-related GHG emissions were analyzed for a single year. The purpose of this carbon footprint analysis was to evaluate if there are significant differences in the GHG emissions associated with each design alternative. Therefore, a single year analysis of the operation-related GHG emissions and a single year analysis of the construction-related GHG emissions was considered appropriate for the comparative alternative evaluations. A full lifecycle carbon footprint analysis combining the construction-related GHG emissions and the lifecycle operation-related GHG emissions was not performed at this time.

As additional detailed design data is developed, a full lifecycle carbon footprint analysis could be conducted in the future.

Table 7.1
Greenhouse Gas Emissions Factors

Components	Literature Value	Units	Conversion to tonne CO2	Units	Source
Construction					
Concrete	0.3	ton Co_2e/m^3	0.272154	tonne Co_2e/m^3	Flower & Sanjayan.2007
Steel (re-bar, piping, equipment)	0.0032	ton C/ton product	0.0032	tonne C/tonne product	EPA, 2003
Excavation (diesel fuel emissions)	0.1	gal/m3	0.000981	tonne/m3	Wilson, personal communication
Conveyance	-	-	-	-	-
Liquid Stream Treatment					
Power for Treatment (electricity)	72	g CO_2e/kw-hr	0.000072	tonne/kwhr	BC Hydro, 2004 report
Treatment Chemicals					
Alum	0.539	kgCO2-e/kg dry	0.000539	tonne/kg Alum	de Haas et al 2008
Chlorine	1.124	kgCO2-e/kg dry	0.001124	tonne/kgCL	de Haas et al 2008
Direct Emissions (CH_4 & N_2O)					
Methane during Treatment and Outflow	0	0	0	0	Willis, personal communication
Nitrous Oxide (outfall)	0.0005-0.25	kg N20-N/kg N	0.000148	tonneCO_2/kg N	IPCC, 2006
Solids Treatment & Disposal					
Power for Treatment (Biosolids treatment & Scrubbing)	72	g CO_2e/kw-hr	0.000072	tonne/kwhr	BC Hydro, 2004 report
Treatment Chemicals (Polymer)	1.182	kg CO_2-e/kg dry	0.001182	tonne/kgPolymer	de Haas et al 2008
Direct Emissions (CH_4 & N_2O)					
Methane from scrubbing	1	% of volume	23	units CO_2/unit methane	
Methane from land application	negligible				Brown, personal communication
Nitrous Oxide from Combustion of Solids	1520-6400	g-N_20/ton DT	1.063360109	tonneCO_2/tDT	Suzuki et al 2003
Power for Soil Amendment Blending	4.17	L fuel/DT solids	0.011	tonnesCO_2/dryton ne	Tagro, personal communication
Transportation (Diesel Fuel)	2637	g CO_2/L	0.002637	tonne/L	Brown, Biocycle 2004; EIA; GRP

Components	Literature Value	Units	Conversion to tonne CO2	Units	Source
Resources from Wastewater					
Saleable Heat for District Heating Offset	50.3	kg/GJ	.0503	tonne CO_2/GJ (based on natural gas)	EIA
Biosolids & Struvite Fertilizer Offset					
Avoidance N fertilizer	3.96	kg CO_2/kg N	0.00396	tonne/kg N	ROU, 2006
Avoidance P fertilizer	1.76	kg CO_2/kg P	0.00176	tonne/ kg P	ROU, 2006
Carbon Sequestration (Soil Amendment & Willow Coppice)	0.3	tonnes CO_2/dry tonne applied	0.3	tonnes CO_2/dry tonne applied	Brown, personal communication
Dried Product Fuel Offset (Cement kiln, etc.)	94.14	kg CO_2/GJ	0.09414	tonne/GJ	Abu-Orf etal 2008; EIA
Willow Coppice Offsets (burning wood)	1000.00	g CO_2/kg wood burned	1	tonne CO_2e/tonne	Climate Registry: GRP 2008
Biocell Gas Capture	0.067	Mg CH_4/Mg solids	0.7705	tonne CO_2e /tonne solids	Brown, personal communication

Assumptions:

- The heat recovery system used for warming the digester and the dryer offsets natural gas use.
- The saleable district heat offsets the natural gas required to heat the district
- Building heat, digester heat and drying are typically offset by digester gas and were therefore, not considered an offset of fossil fuels
- No methane is emitted from the digester.
- No methane is emitted from the conveyance system.
- One percent of methane is lost as fugitive emissions from the scrubber.
- The 2004 average annual emissions factor for electricity from BC Hydro was used. A heating season emissions factor was not included due to the fact that the actual usage for 2005 was much lower than the BC hydro projection for that year. The 2008 projection is assumed to also be too high.
- The offsets due to reclaimed water are expected to be minimal and were not included in this analysis due to a lack of available data at this time.
- No environmental life cycle costs were assumed for the soil product mixing materials of wood and sand.

- The biosolids results in this analysis are based on preliminary design assumptions and are subject to refinement after determination of actual solids characteristics and analysis of design options under Canadian regulations.
- In determination of the fertilizer offsets, total nitrogen was used instead of available nitrogen as a simplification.
- Emissions associated with treatment chemicals used in liquid stream treatment were not included due to lack of data available at this time on chemical quantity usage.
- The biocell will capture approximately 50% of the emissions that would be released by landfill of biosolids (assuming it is not covered).
- Offsets associated with co-digestion of organic waste beyond increased gas production were not included in the analysis at this time due to a lack of available data.

7.2 Carbon Footprint Impact

The estimated annual carbon footprint in tonnes of CO2 associated with each treatment option in the design year of 2030 is summarized in **Table 7.2**. This analysis is based on initial design assumptions for each alternative. Further refinement of this analysis will be conducted in the future as the alternatives analysis and design process proceeds.

The results of this analysis indicate that the overall net carbon footprint of all three alternatives is negative due to the extensive utilization of wastewater resources such as biosolids, biogas, and heat recovery in the system design, which offsets the use of fossil fuels. A negative carbon footprint indicates a beneficial environmental impact related to GHG emissions. For recovered heat it has been assumed that 5% of the available heat is used in 2016 increasing to 25% in 2030 and 65% for 2065.

The carbon footprint associated with each of the alternatives is estimated to be very similar based on the available data and assumptions from the preliminary design. For operation-related emissions, all three alternatives are estimated to have a similar negative carbon footprint.

Table 7.2
Summary of GHG Emissions Associated with Alternatives in 2030 design year (Tonne CO2e/yr)

Components	Option 1A
Construction (Emissions associated with concrete and steel production and site excavation) **One time** emission during construction period. Therefore, not included in 2030 design year total	15,516
Conveyance	
Direct GHG Emissions (Assumed zero for this analysis)	0
Power for Conveyance (pumping)	204
Liquid Stream Treatment	
Power for Treatment	3,071
Heat Pump Power for District Heating	3,182
Direct Emissions (CH_4 & N_2O)	12
Biosolids / Resource Recovery	
Biomethane	-8,062
Cement Kiln Offset	-1,742
District Heating	-13,962
Total Annual Emissions Design Year 2030 **(Excluding one time construction-related emissions)**	**-17,297**

7.3 Recovery of Saleable Products & Greenhouse Gas Offsets

The potential saleable products included in the alternative designs include: methane biogas, recovered heat, struvite, a biosolids topsoil product and dried fuel product, wood chips for energy offsets and reclaimed water. For a discussion of the production and benefit of these products refer to Section 6 of this report. Each of these products is derived from the renewable source of wastewater residuals. A subsequent benefit is that renewable sources of energy and nutrients can provide an offset of equivalent GHG emissions associated with nonrenewable sources of energy and nutrients. A brief overview of the GHG offsets incorporated in this analysis related to these products is provided in this section.

Table 7.1 summarizes the emissions factors associated with the offsets described in this section. The emissions factors associated with the offsets are based on professional judgment of the best available data and research at this time. As additional data and research becomes available, emissions factors associated with offsets may be modified in the future.

For the purposes of this carbon footprint analysis, GHG offsets refer to the amount of anthropogenic greenhouse gases avoided by utilizing alternative renewable resources. For example, digester gas captured during anaerobic digestion of solids can be scrubbed and sold as a biogas product. The digester gas is used in lieu of natural gas or other fossil fuels. Because the burning of natural gas releases anthropogenic GHG, the amount of natural gas not burned due to the capture and use of digester gas is considered an offset for the purposes of this analysis. When food sources such as brown grease are added to the digester to boost gas production, the offsets associated with use of the digester gas are increased.

Heat recovery at the wastewater treatment facilities involves recovery of heat from the digester effluent with heat pumps, and the use of recovered heat to provide process heating at the facility, building heating, and regional heating through a pumped heat loop. Although heat recovery requires the input of electricity, the electrical equivalent of the heat that is recovered is greater than the input, resulting in a net reduction in electricity or fuel usage for heating purposes. In the alternatives analysis, the heat pumps are estimated to provide a coefficient of performance of about 3.5. This means that for every 1kW of electricity sent to the heat pumps, 3.5kW of heat will be provided to the heat loop. The net reduction in fuel usage required for heating with the use of heat pumps is taken into account as an offset for this analysis.

Struvite, biosolids topsoil products and reclaimed water are other resources that provide sources of GHG offsets. These products can be land applied in place of chemical fertilizers, offsetting the industrial production of nitrogen and phosphorous. Biosolids also provide an additional benefit by sequestering carbon in “disturbed” soils by adding organic matter, which increases the soil carbon and the soil storage capacity.

A dried biosolids fuel product as well as wood chips (derived from trees grown where biosolids are applied) can be used in lieu of burning of coal as a heat/energy source in cement manufacturing, pulp mills or waste to energy facilities. Although the nutrient value of the biosolids is lost during this practice, the use of fossil fuels in these processes is reduced which results in a carbon offset.

Section 8 Opinion of Probable Capital Costs

8.1 Cost Basis

Detailed capital and life cycle cost estimates have been prepared for the selected option and are included in Appendix A. The cost estimate is considered a Class C estimate and includes appropriate allowances and contingencies for a project of magnitude. The percentages used in the estimates for direct and indirect costs are based on experience with other highly complex projects.

The cost estimates are comprised of the following and include factors appropriate for a project at this stage:

Direct Costs

- Capital construction costs including project general requirements.
- Construction contingency costs at 15% of construction costs.

Indirect Costs

- Engineering at 15% of direct costs.
- Administration and program management costs at 6% of direct costs.
- Miscellaneous at 2% of direct costs.

Financing Costs

- Interim Financing at 4% of direct and indirect costs.
- Inflation to Midpoint of construction 2% per annum to 2014.

It is noted that capital costs could vary depending on market conditions at time of tender, the overall procurement strategy and the risk profile of a particular project.

8.2 Capital Costs

To arrive at preliminary capital costs conceptual level layouts were prepared for facilities and sited on the potential sites under consideration. Representative technologies were selected for the purposes of preparing cost estimates at each site. Drawings and cost estimates are appended to this report. The capital costs (rounded to nearest $1 million) for each option are summarized in **Table 8.1**.

Table 8.1
Capital Costs

Capital Costs	Option 1A
Total Capital Costs	$967,531,000

Capital costs are subject to some modification depending on the degree of mitigation and further more detailed engineering works.

8.3 Operations and Maintenance Costs

Table 8.2 provides operations and maintenance costs for each option.

Table 8.2
Annual O&M Costs

	Option 1A
Annual O&M Costs	$19,080,000

Annual operation and maintenance costs are considered similar for all options and does not consider offsets from potential revenue from resource recovery.

8.4 Life Cycle Costs

Life cycle costs were prepared using a net present value approach and a 6% discount rate. The life cycle costs include capital and operating costs and repair and replacement costs over a 25 year period.

Table 8.3
Life Cycle Costs

Costs	Option 1A
Life Cycle Costs	$1,332,141,000

Section 9 Risk Assessment

9.1 Methodology

Many communities are using risk assessment to identify and quantify the severity of risk associated with capital projects. Each project has a different risk profile. Quantification of risks can assist decision makers in the selection of options and identification and mitigation of project specific issues. For the CRD CAWTP the use of risk assessment provides a good technique to highlight the risks that are known at this time. As the project develops and more information becomes available the risk assessment can be updated and mitigation strategies can be developed for each of the identified risk factors.

Section 9.3 provides an outline of risks which are known at this time. This risk matrix is preliminary only and will be further developed as the project proceeds.

9.2 Risk Matrix

A preliminary risk matrix (Table 9.1) has been prepared for Option 1A. A number of risk factors have been considered. These include siting risks, construction cost risk, constructability and a number of others. Each of these risks are ranked using a simple probability of occurrence using a 1 to 3 ranking. The risk impact is also ranked 1 – 3 with 1 being low impact and 3 being high impact. The factor of the probability and impact provides an overall risk factor. This technique is useful in providing a high level screening of risk factors. As the project develops more detailed risk assessment and workshops can be completed with various stakeholders and CRD staff.

9.3 Risk Ranking

The project was ranked in consideration of the risk categories applicable to each of the major project components. The risks associated with each site under consideration for construction of facilities have been assessed. It also considers the risk associated with the various conveyance systems, social risks and construction risks.

RISK IDENTIFICATION			RISK ASSESSMENT			RISK MITIGATION
CATEGORY	RISK	DATE IDENTI-FIED	PROB. HIGH = 3 MED = 2 LOW = 1	IMPACT HIGH = 3 MED = 2 LOW = 1	RISK FACTOR HIGH > 5 MED 4 - 5 LOW < 4	RISK CONTROL STRATEGIES / ACTIONS
RISK – OPTION 1A						
Site	McLoughlin Point					
	• Timing of Environmental Clean-up not within the project schedule		3	3	9	
	• Rezoning may not be approved		2	3	6	
	• Imperial Oil decides the site is too costly to remediate and does not sell		1	3	3	
	• Site Remediation Costs		3	3	9	
	• Access agreements with DND		1	1	1	
	• Aesthetics		2	2	4	
	• Rock Excavation		3	3	9	
	• Constructability		3	3	9	
	• Space		3	3	9	
	• Traffic		1	1	1	
	• Community Use		1	1	1	
	• Noise		1	1	1	
	• Odour Control		1	2	2	
	• Impacts on Adjacent Residents		1	1	1	
Site	Saanich East - North Oak Bay					
	• Site Purchase		1	1	1	
	• Noise		1	2	2	
	• Odour		1	2	2	
	• Visual Impacts		1	2	2	
	• Vibration		1	2	2	
	• Truck Traffic		1	1	1	
	• Impacts on Forest		2	2	4	
	• Environmental Impacts		1	2	2	
	• Wildlife Impacts		1	2	2	
	• Community Use		2	2	4	
	• Property Value Impact		1	2	2	
Site	West Shore					
	• Community Use		2	2	4	
	• Site Purchase		3	3	9	
	• Constructability		1	1	1	
	• Space		1	1	1	
	• Traffic		2	2	4	

RISK IDENTIFICATION			RISK ASSESSMENT			RISK MITIGATION
CATEGORY	RISK	DATE IDENTI-FIED	PROB. HIGH = 3 MED = 2 LOW = 1	IMPACT HIGH = 3 MED = 2 LOW = 1	RISK FACTOR HIGH > 5 MED 4 - 5 LOW < 4	RISK CONTROL STRATEGIES / ACTIONS
	• Noise		1	2	2	
	• Odour Control		1	2	2	
	• Impacts on Adjacent Residents		2	2	4	
	• Space for Future Expansion		1	1	1	
Site	Clover Point					
	• Community Use		3	3	9	
	• Visual Impact		3	2	6	
	• Space		3	2	6	
	• Odour		1	2	2	
	• Noise		1	2	2	
	• Traffic		1	2	2	
	• Constructability		3	2	6	
	• Impact to Adjacent Residents		2	2	4	
Site	Macaulay Point					
	• Community Use		1	1	1	
	• Visual Impact		1	1	1	
	• Space		3	1	3	
	• Odour		1	2	2	
	• Noise		1	1	1	
	• Traffic		1	1	1	
	• Constructability		2	2	4	
	• Impact to Adjacent Residents		2	2	4	
Site	Hartland Landfill Bisolids					
	• Community		2	2	4	
	• Visual Impact		2	2	4	
	• Space		1	1	1	
	• Odour		2	2	4	
	• Noise		2	2	4	
	• Traffic		2	2	4	
	• Constructability		2	2	4	
	• Impact to Adjacent Neighbours		1	1	1	
Stakeholders	Acceptance		2	2	4	
	Mitigation Strategies / Costs		2	2	4	
	Social Concerns		2	2	4	
Engineering	Treatment Technology Selection		2	1	2	

RISK IDENTIFICATION			RISK ASSESSMENT			RISK MITIGATION
CATEGORY	RISK	DATE IDENTI-FIED	PROB. HIGH = 3 MED = 2 LOW = 1	IMPACT HIGH = 3 MED = 2 LOW = 1	RISK FACTOR HIGH > 5 MED 4 - 5 LOW < 4	RISK CONTROL STRATEGIES / ACTIONS
	Resource Recovery		2	2	4	
	Foundation / Site Conditions		2	1	2	
	Carbon Footprint		1	1	1	
	Biosolids Treatment		2	2	4	
Financial	Capital Cost / Affordability		2	3	6	
	Operations / Maintenance Costs		1	2	2	
	Available Funding		2	2	4	
	Funding Conditions / Restrictions		2	2	4	
	Cost Escalation		2	2	4	
	Contingency Items		2	2	4	
	Financing Costs		1	1	1	
Procurement	Procurement Strategy		2	1	2	
Construction	Cost		2	3	6	
	Market Conditions		1	3	3	
	Schedule / Delays		2	3	6	
	Changes / Claims		2	2	4	
Other	Natural Disaster		1	3	3	
	Global Warming		1	1	1	
	Treatment System Failure		1	2	2	
	Sludge Pipeline		3	2	6	
	Archeological Conditions		2	2	4	

Section 10 Discussion of Analysis and Recommendation

10.1 Summary of Siting Investigations

Option 1A, with the main secondary plant at McLoughlin Point is a viable option because of its proximity to the Macaulay and Clover Point outfalls and the fact that the site is available for purchase. The McLouglin site is contaminated and will require remediation. A site has been identified at Hartland Landfill for the biosolids treatment facilities.

The Saanich East North Oak Bay plant will be located on a parcel of land owned by the CRD. The preliminary site selected by the West Shore communities for West Shore plant is adjacent to the Juan de Fuca Recreation Centre.

10.2 Siting of Biosolids Facilities

For Option 1A biosolids treatment facilities will be located at a site remote from McLoughlin WWTP at the Hartland Landfill. This site is located approximately 17.7 km from the McLoughlin Point and will require construction of pumping stations and pipeline to transfer sludge from the McLoughlin site to Harland landfill. The opportunity for heating digesters from secondary effluent would likely not be economical for this option. However the location of the digesters at Hartland would provide good synergies for integration of solid wastes with biosolids. It would also be a good location for acceptance of and processing of FOG and food wastes to enhance digester gas production. In the future, waste-to-energy facilities could also be integrated into this site more readily.

10.3 Wet Weather Treatment Facilities

Under Option 1A initial investigation indicates that the Macaulay wet weather facilities can be incorporated into the McLoughlin Point plant, thereby resulting in cost savings. The footprint of the Clover Point Wet Weather Treatment facility is compact and can be accommodated adjacent to the Clover Point pump station.

10.4 Resource Recovery & Carbon Footprint

The potential for resource recovery has been investigated and all options have a similar potential. The CRD has an opportunity to establish resource recovery facilities for reclaimed water, heat recovery, biomethane, soil amendment, struvite recovery and other resources. Further investigations are currently under way to assess these opportunities at Saanich East - North Oak Bay / UVic and James Bay.

One of the key drivers for implementation of resource recovery will be the market potential for immediate use of these resources. The market for use of these resources is being investigated under separate studies. It is suggested that resource recovery facilities be planned in a phased approach. Basic infrastructure can be configured to permit easy addition of resource recovery systems and specific facilities can then be constructed to match market demands.

The design for all options can be developed to offset greenhouse gases and provide a carbon positive project. By recovering heat, biomethane, reclaimed water and other resources the impact from operation at the plants and operating costs can be reduced. One significant example is the recovery of heat from treated effluent to heat digesters and buildings. Studies are currently being completed to assess resource recovery options in the UVic and James Bay area.

10.5 Recommendation

Based on the work completed as part of the project, the project team recommends the following:

1. Carry forward with the Business Case and grant applications using Option 1A configuration.

2. Proceed with finalizing the West Shore site.

3. Proceed with further technical development and public consultation for all facilities.

4. Continue to further develop resource recovery opportunities and explore the market potential for use of recovered resources.

5. Implement the biosolids plan in accordance with the recommendations of the Biosolids Management Plan dated November 4, 2009.

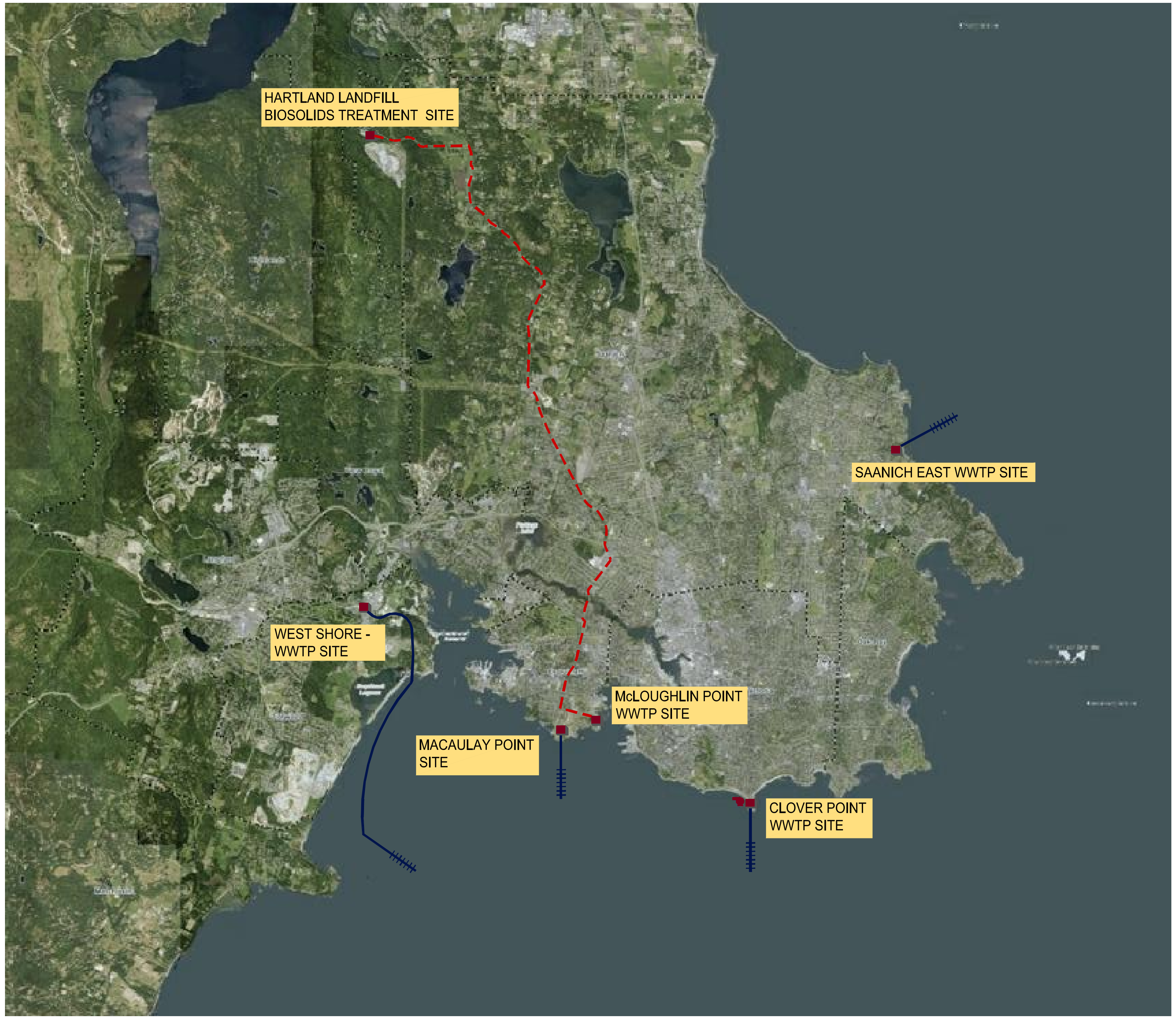
Appendix A

Detailed Cost Estimates - Confidential

Appendix B

Drawings

CAPITAL REGIONAL DISTRICT
CORE AREA WASTEWATER TREATMENT PROGRAM
OPTION 1A



LIST OF DRAWINGS

DWG. No.	TITLE
A1-G-000	COVER PAGE AND DRAWING INDEX
A1-G-002	OPTION 1A – KEY PLAN
A1-G-005	OPTION 1A – 3D RENDERINGS
ES-A1-C-010	SITE PLAN – OPTION 1A – SAANICH EAST SITE
ES-A1-G-010	DESIGN CRITERIA – OPTION 1A – SAANICH EAST SITE
ES-A1-G-015	PROCESS FLOW DIAGRAM – OPTION 1A – SAANICH EAST SITE
ES-A1-P-100	GEN. ARRANGEMENT PLAN – HEADWORKS/ODOUR CONTROL OPTION 1A – SAANICH EAST SITE
ES-A1-P-101	GEN. ARRANGEMENT SECTION – HEADWORKS/ODOUR CONTROL OPTION 1A – SAANICH EAST SITE
ES-A1-P-200	GEN. ARRANGEMENT PLAN – HIGH RATE PRIMARY CLARIFIER (LAMELLA) PLATE WITH CEP OPTION 1A – SAANICH EAST SITE
ES-A1-P-201	GEN. ARRANGEMENT – SECTIONS – HIGH RATE PRIMARY CLARIFIERS (LAMELLA PLATE) WITH CEP OPTION 1A – SAANICH EAST SITE
ES-A1-P-300	GEN. ARRANGEMENT PLAN – MEMBRANE BIOREACTOR SECONDARY TREATMENT OPTION 1A – SAANICH EAST SITE
ES-A1-P-301	GEN. ARRANGEMENT – SECTIONS – MEMBRANE BIOREACTOR SECONDARY TREATMENT OPTION 1A – SAANICH EAST SITE
ES-A1-P-500	GEN. ARRANGEMENT PLAN – AUXILLARY BUILDING OPTION 1A – SAANICH EAST SITE
CL-A-C-010	SITE PLAN – WET WEATHER TREATMENT FACILITY – OPTION 1A – CLOVER POINT SITE
CL-A-G-010	DESIGN CRITERIA – WET WEATHER TREATMENT FACILITY – OPTION 1A – CLOVER POINT SITE
CL-A-G-015	PROCESS FLOW DIAGRAM – WET WEATHER TREATMENT FACILITY – OPTION 1A – CLOVER POINT SITE
CL-A-P-200	PLAN – HEADWORKS/ACTIFLOW – OPTION 1A – CLOVER POINT SITE
CL-A-P-201	SECTIONS – HEADWORKS/ACTIFLO – OPTION 1A – CLOVER POINT SITE
MC-A-C-010	SITE PLAN – PUMP STATION EXPANSION – OPTION 1A – MACAULAY POINT SITE
MC-A-G-015	PROCESS FLOW DIAGRAM – PUMP STATION EXPANSION – OPTION 1A – MACAULAY POINT SITE
MC-A-P-200	PLAN, PUMP STATION EXPANSION – OPTION 1A – MACAULAY POINT SITE
MC-A-P-201	SECTION, PUMP STATION EXPANSION – OPTION 1A – MACAULAY POINT SITE
ML-A1-C-010	SITE PLAN – BAF SECONDARY TREATMENT – OPTION 1A – (BAF) McLOUGHLIN POINT SITE
ML-A1-G-010	DESIGN CRITERIA – OPTION 1A – (BAF) – McLOUGHLIN SITE
ML-A1-G-011	DESIGN CRITERIA – BIOSOLIDS – OPTION 1A – (BAF) – McLOUGHLIN SITE – HARTLAND LANDFILL SITE
ML-A1-G-015	PROCESS FLOW DIAGRAM – OPTION 1A – (BAF) – McLOUGHLIN SITE
ML-A1-P-100	GEN. ARRANGEMENT PLAN – HEADWORKS/ODOUR CONTROL OPTION 1A – McLOUGHLIN SITE
ML-A1-P-101	GEN. ARRANGEMENT – SECTIONS – SCREENING / GRIT REMOVAL FACILITY OPTION 1A McLOUGHLIN SITE
ML-A1-P-200	GEN. ARRANGEMENT – PLAN – PRIMARY CLARIFIERS (LAMELLA PLATE) WITH CEP OPTION 1A McLOUGHLIN SITE
ML-A1-P-201	GEN. ARRANGEMENT – SECTIONS – PRIMARY CLARIFIERS (LAMELLA PLATE) WITH CEP OPTION 1A McLOUGHLIN SITE
ML-A1-P-300	GEN. ARRANGEMENT – PLANS – BIOLOGICAL AERATED FILTER & WATER REUSE OPTION 1A – McLOUGHLIN SITE
ML-A1-P-301	GEN. ARRANGEMENT – SECTIONS – BIOLOGICAL AERATED FILTER OPTION 1A McLOUGHLIN SITE
ML-A1-P-400	GEN. ARRANGEMENT – PLAN AND SECTION – UV BUILDING FOR SECONDARY EFFLUENT – OPTION A McLOUGHLIN SITE
WS-A1-C-010	SITE PLAN – CONVENTIONAL ACTIVATED SLUDGE PROCESS – OPTION 1A WEST SHORE SITE
WS-A1-G-010	DESIGN CRITERIA – OPTION 1A – WEST SHORE SITE
WS-A1-G-015	PROCESS FLOW DIAGRAM – OPTION 1A – WEST SHORE SITE
WS-A1-P-100	GENERAL ARRANGEMENT PLAN – HEADWORKS – OPTION 1A – WEST SHORE SITE
WS-A1-P-101	GENERAL ARRANGEMENT – SECTIONS – SCREENING/GRIT REMOVAL FACILITY – OPTION 1A WEST SHORE SITE
WS-A1-P-200	GENERAL ARRANGEMENT – PLAN – HIGH RATE PRIMARY CLARIFIERS (LAMELLA PLATE) WITH CEP OPTION 1A – WEST SHORE SITE
WS-A1-P-201	GENERAL ARRANGEMENT – SECTIONS – HIGH RATE PRIMARY CLARIFIERS (LAMELLA PLATE) WITH CEP OPTION 1A – WEST SHORE SITE
WS-A1-P-300	GENERAL ARRANGEMENT – PLAN – CAS & SECONDARY CLARIFIERS – OPTION 1A WEST SHORE SITE
WS-A1-P-400	GENERAL ARRANGEMENT – PLAN & SECTION – UV BUILDING FOR SECONDARY EFFLUENT – OPTION 1A WEST SHORE SITE
WS-A1-P-500	GENERAL ARRANGEMENT – PLAN – SLUDGE THICKENING BUILDING – OPTION 1A WEST SHORE SITE
HL-A1-C-010	SITE PLAN BIOSOLIDS TREATMENT FACILITY – OPTION 1A – HARTLAND LANDFILL SITE
HL-A1-C-011	200ø SLUDGE PIPELINE – OPTION 1A – HARTLAND LANDFILL SITE

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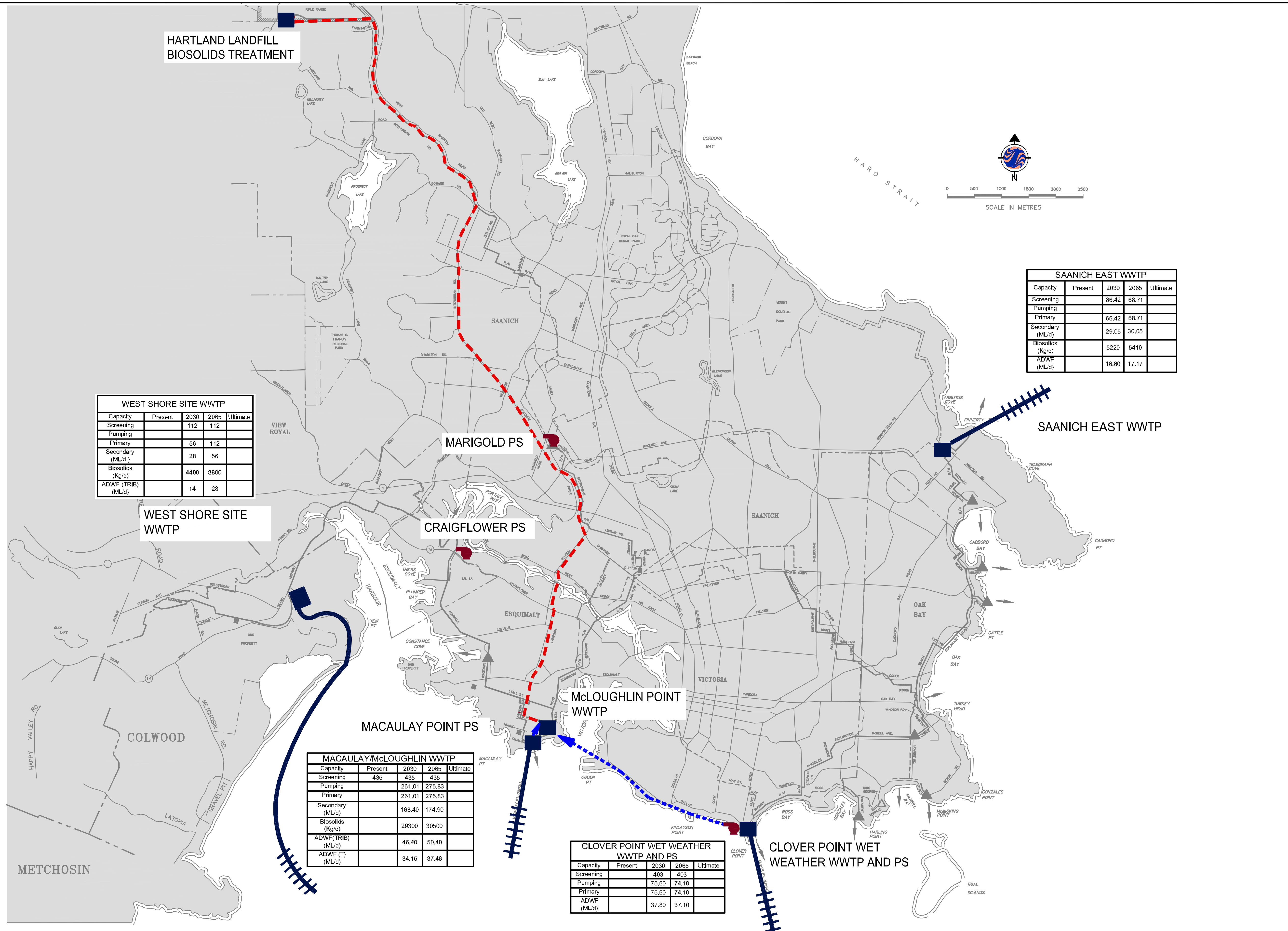

WEST SHORE SITE WWTP				
Capacity	Present	2030	2065	Ultimate
Screening		112	112	
Pumping				
Primary		56	112	
Secondary (ML/d)		28	56	
Biosolids (Kg/d)		4400	8800	
ADWF (TRIB) (ML/d)		14	28	

SAANICH EAST WWTP				
Capacity	Present	2030	2065	Ultimate
Screening		66.42	68.71	
Pumping				
Primary		66.42	68.71	
Secondary (ML/d)		29.05	30.05	
Biosolids (Kg/d)		5220	5410	
ADWF (ML/d)		16.60	17.17	

MACAULAY/McLOUGHLIN WWTP				
Capacity	Present	2030	2065	Ultimate
Screening	435	435	435	
Pumping		261.01	275.83	
Primary		261.01	275.83	
Secondary (ML/d)		168.40	174.90	
Biosolids (Kg/d)		29300	30500	
ADWF(TRIB) (ML/d)		46.40	50.40	
ADWF (T) (ML/d)		84.15	87.48	

CLOVER POINT WET WEATHER WWTP AND PS				
Capacity	Present	2030	2065	Ultimate
Screening		403	403	
Pumping		75.60	74.10	
Primary		75.60	74.10	
ADWF (ML/d)		37.80	37.10	

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DESIGNED RAF	SURVEYED –	OPTION 1A KEY PLAN
DRAWN PRC	DATE 08/12/09	
SCALE HORIZONTAL N.T.S	CHECKED	
SCALE VERTICAL –	APPROVED RAF	CONTRACT NUMBER – / DRAWING NUMBER A1–G–002 / ISSUE – / SHT. No. – OF –

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OPERATONS BUILDING (LOOKING NORTHWEST)

OPERATONS BUILDING (LOOKING SOUTHEAST)

AERIAL VIEW (LOOKING SOUTHWEST)

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SCALE VERTICAL	–	APPROVED	RAF

CORE AREA WASTEWATER TREATMENT PROGRAM

Mc LOUGHLIN PT. SITE
OPTION 1A
3D RENDERINGS

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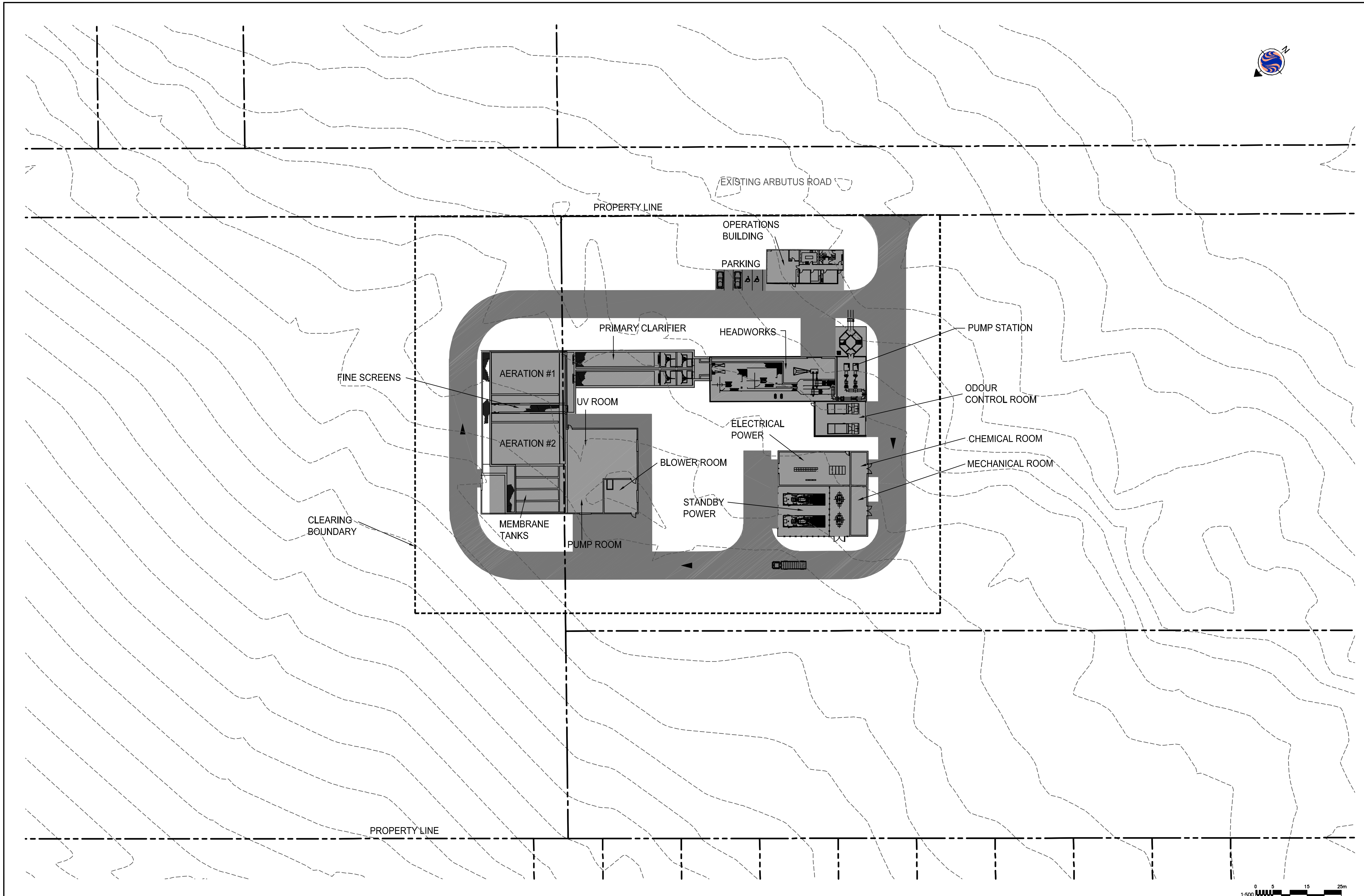

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CORE AREA WASTEWATER TREATMENT PROGRAM

SAANICH EAST SITE
OPTION 1A
SITE PLAN

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East Saanich Wastewater Treatment Facility (Major euqipment is designed for year 2065 flow)	
	Option 1A
Design Parameters	**East Saanich Wastewater Treatment Plant**
Year 2030 ADWF (ML/d)	16.6
Year 2065 ADWF (ML/d)	17.17
Influent Pumping Station:	
Total Pumping Capacity (ML/d)	68.7
No. of Pumps (including One Standby)	2
Forceman Diameter (mm)	750
Headworks:	
Screening Hydraulic Capacity (ML/d)	68.7
No. of Screens with Compactors	2
Screen Size (mm)	6
Vortex Grit Removal Capacity (ML/d)	68.7
No. of Vortex Grit Chambers	2
Diameter of Vortex Grit Chamber	3600
No. of Grit Classifiers	1
High Rate Primary Clarifier with Lamella Plates and with CEPT Capability:	
Primary Treatment Capacity (ML/d)	68.7
No. of Primary Clarifier Trains	2
Type of Clarifier	Rectangular
Side Water Depth (m)	4.5
Surface Overflow Rate (m/h)	13
Lamella Plate Length (m)	3
Lamella Spacing (mm)	75
Lamella Plate Angle to Horizontal (Degree)	55
Lamella Plate Loading Rate (m/d)	32
Rapid Mix Detention Time (sec)	30
Rapid Mix G-Value (s^{-1})	5000
2-stage Flocculation Detention Time (min.)	10
Stage-1 Flocculation G-Value (s^{-1})	75 to 200
Stage-2 Flocculation G-Value (s^{-1})	25 to 100
Coagulant (Alum) Dosage (mg/L)	70 to 80
Coagulant Aid (Polymer) Dosage (mg/L)	1.5
Membrane Bioreactor (MBR):	
Secondary Treatment Hydraulic Capacity (ML/d)	30.05
No. of Aerobic Trains	2
No. of Membrane Trains	4
Total Aerobic Volume (excluding membranes) (m^3)	2840
Combined Membrane Tank Volume (m^3)	664
Design HRT (h)	3.3
Design SRT (d)	17
Bioreactor MLSS (mg/L)	8000 to 10000
Water Depth (m)	5.5

Disinfection for Water Reuse:	
Design Flow for Water Reuse (ML/d)	6
No. of UV Reactors	2
Reactor Flange Size (mm)	300
Minimum UV Transmittance	70%
Maximum Total Suspended Solids (mg/L)	5
Design UV Dose (mJ/cm^2)	80
Disinfection Limit (Fecal Coliform MPN / 100 ml)	2.2
Sodium Hypochlorite Solution Concentration	12%
Disinfection for Secondary Effluent:	
Design Flow (ML/d)	29
No. of UV Channels	2
No. of UV Banks	4
Minimum UV Transmittance	60%
Maximum Total Suspended Solids (mg/L)	30
Design UV Dose (mJ/cm^2)	24000
Disinfection Limit (Fecal Coliform MPN / 100 ml)	200
Outfall:	
Existing Outfall Diameter (mm)	600
New Outfall Diameter (mm)	900
New Outfall Length (m)	1500

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SCALE VERTICAL	–	APPROVED	RAF

CORE AREA WASTEWATER TREATMENT PROGRAM

SAANICH EAST SITE
OPTION 1A
DESIGN CRITERIA

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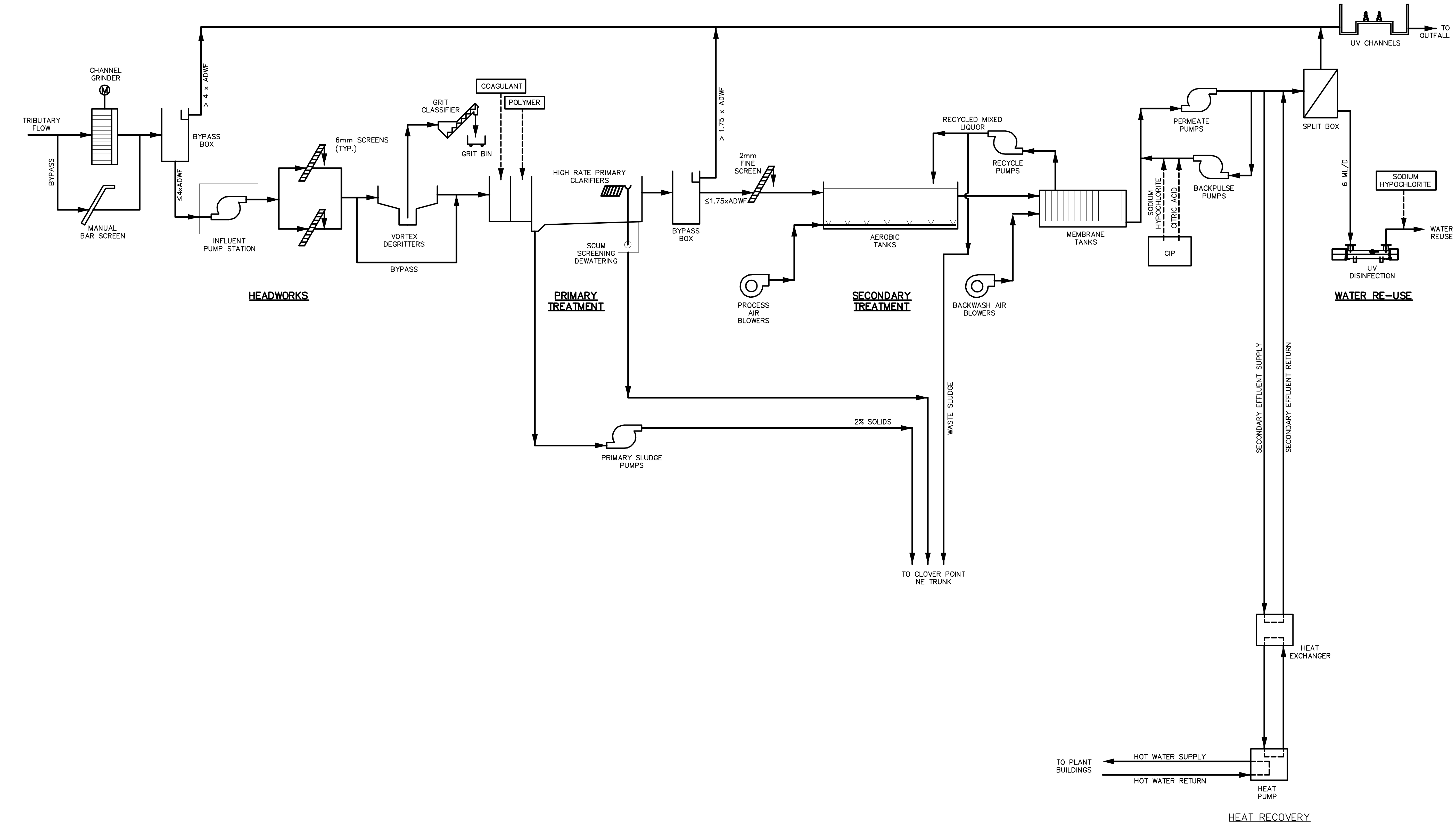

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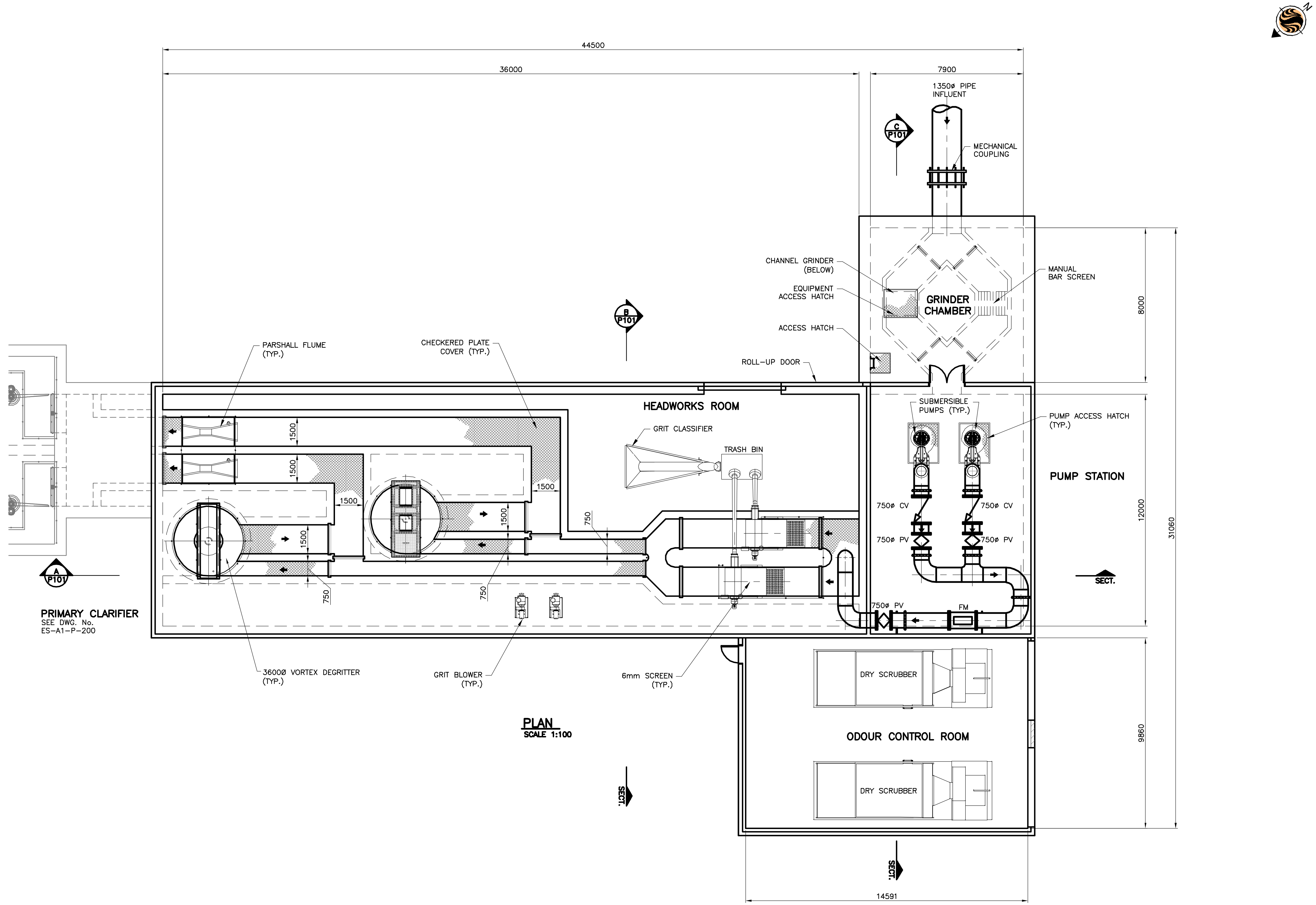
SCALE HORIZONTAL	–	CHECKED	PP
SCALE VERTICAL	–	APPROVED	RAF

CORE AREA WASTEWATER TREATMENT PROGRAM

SAANICH EAST SITE
OPTION 1A
PROCESS FLOW DIAGRAM

CONTRACT NUMBER – DRAWING NUMBER ES–A1–G–015 ISSUE – SHT. No. – OF –



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November 13, 2009 12:13 p.m.

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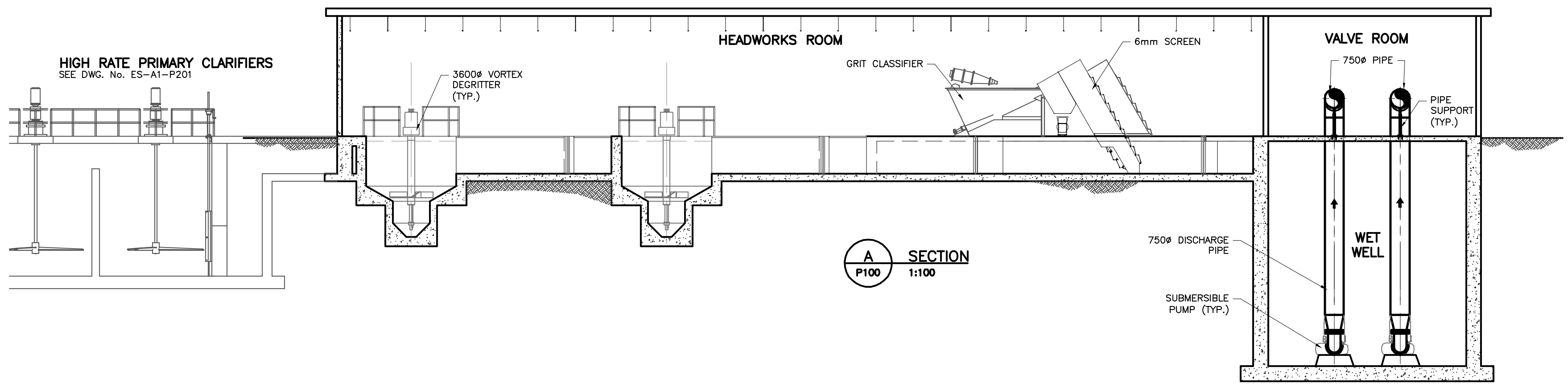
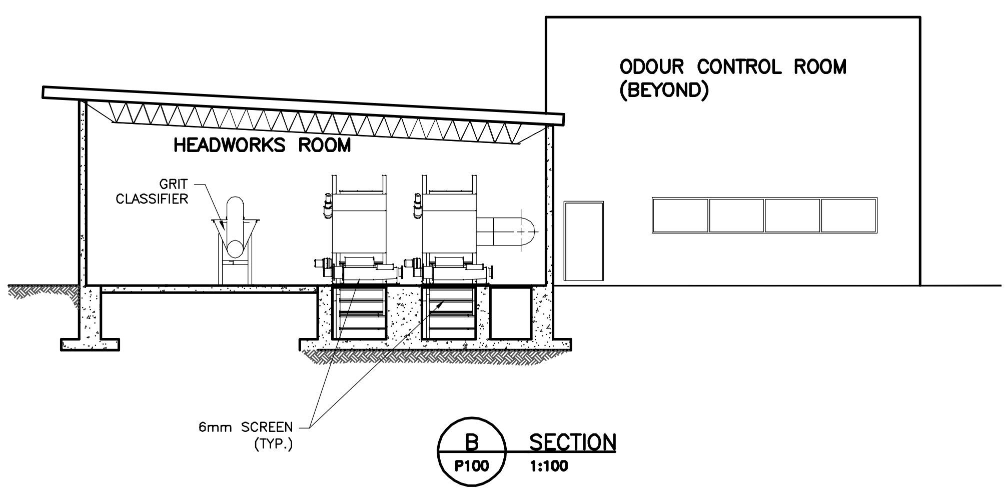
SCALE VERTICAL –	APPROVED RAF

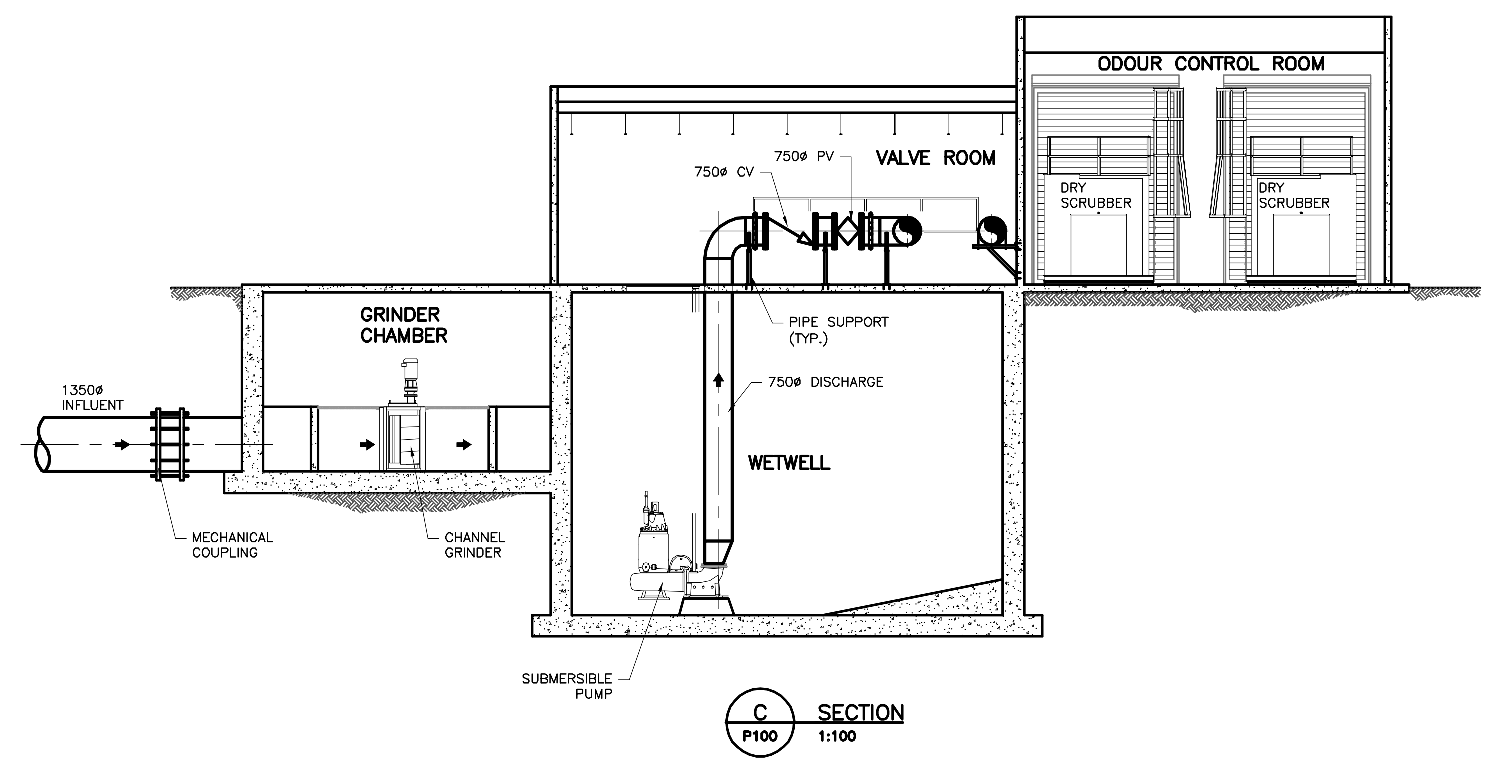
CORE AREA WASTEWATER TREATMENT PROGRAM

SAANICH EAST SITE
OPTION 1A
HEADWORKS/ODOUR CONTROL
GENERAL ARRANGEMENT PLAN

CONTRACT NUMBER	DRAWING NUMBER	ISSUE	SHT. No. OF
–	ES–A1–P–100	–	– OF –







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SCALE VERTICAL –	APPROVED RAF

CORE AREA WASTEWATER TREATMENT PROGRAM
SAANICH EAST SITE
OPTION 1A
HEADWORKS/ODOUR CONTROL
GENERAL ARRANGEMENT – SECTIONS

CONTRACT NUMBER – | DRAWING NUMBER ES-A1-P-101 | ISSUE – | SHT. No. – OF –

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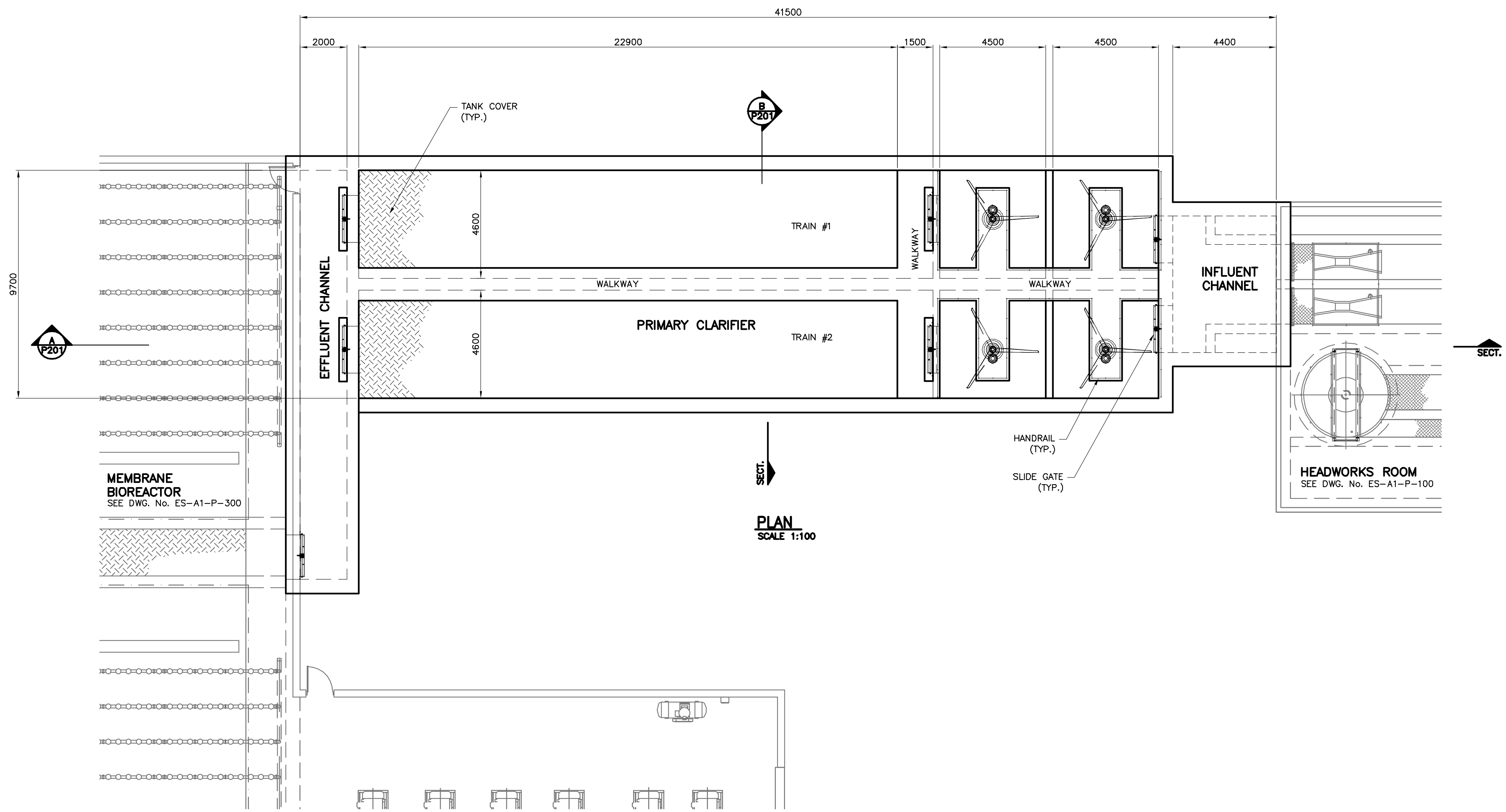

PLAN
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November 20, 2009 10:04 a.m.

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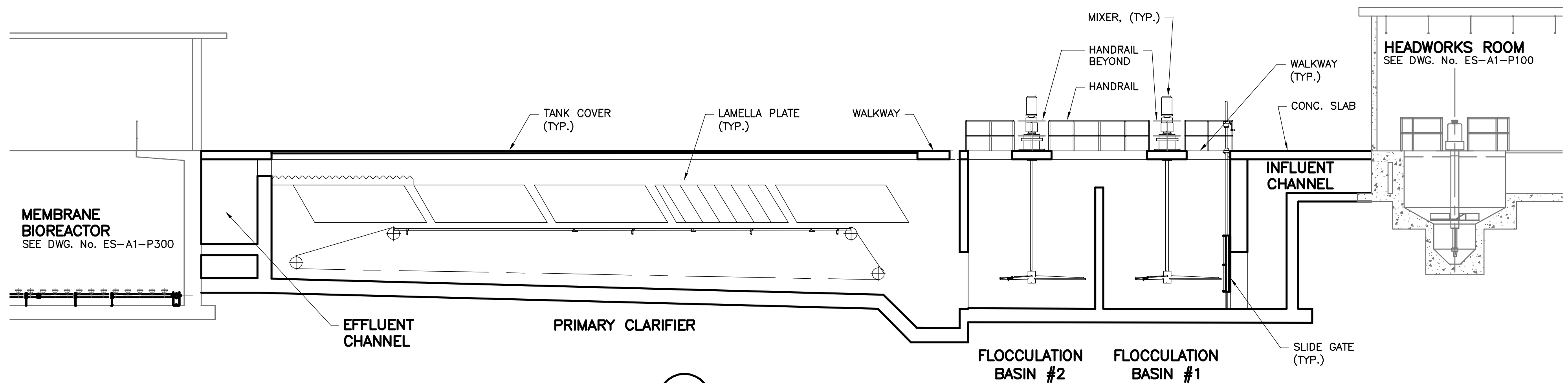
SCALE VERTICAL	–	APPROVED	RAF

CORE AREA WASTEWATER TREATMENT PROGRAM
SAANICH EAST SITE
OPTION 1A
HIGH RATE PRIMARY CLARIFIERS (LAMELLA PLATE) WITH CEP
GENERAL ARRANGEMENT – PLAN

CONTRACT NUMBER – | DRAWING NUMBER ES-A1-P-200 | ISSUE – | SHT. No. – OF –



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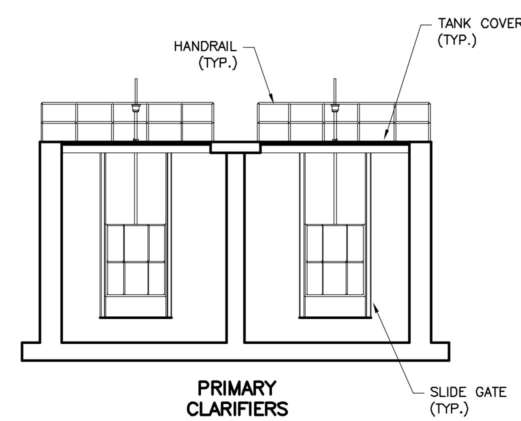

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November 20, 2009 10:06 a.m.

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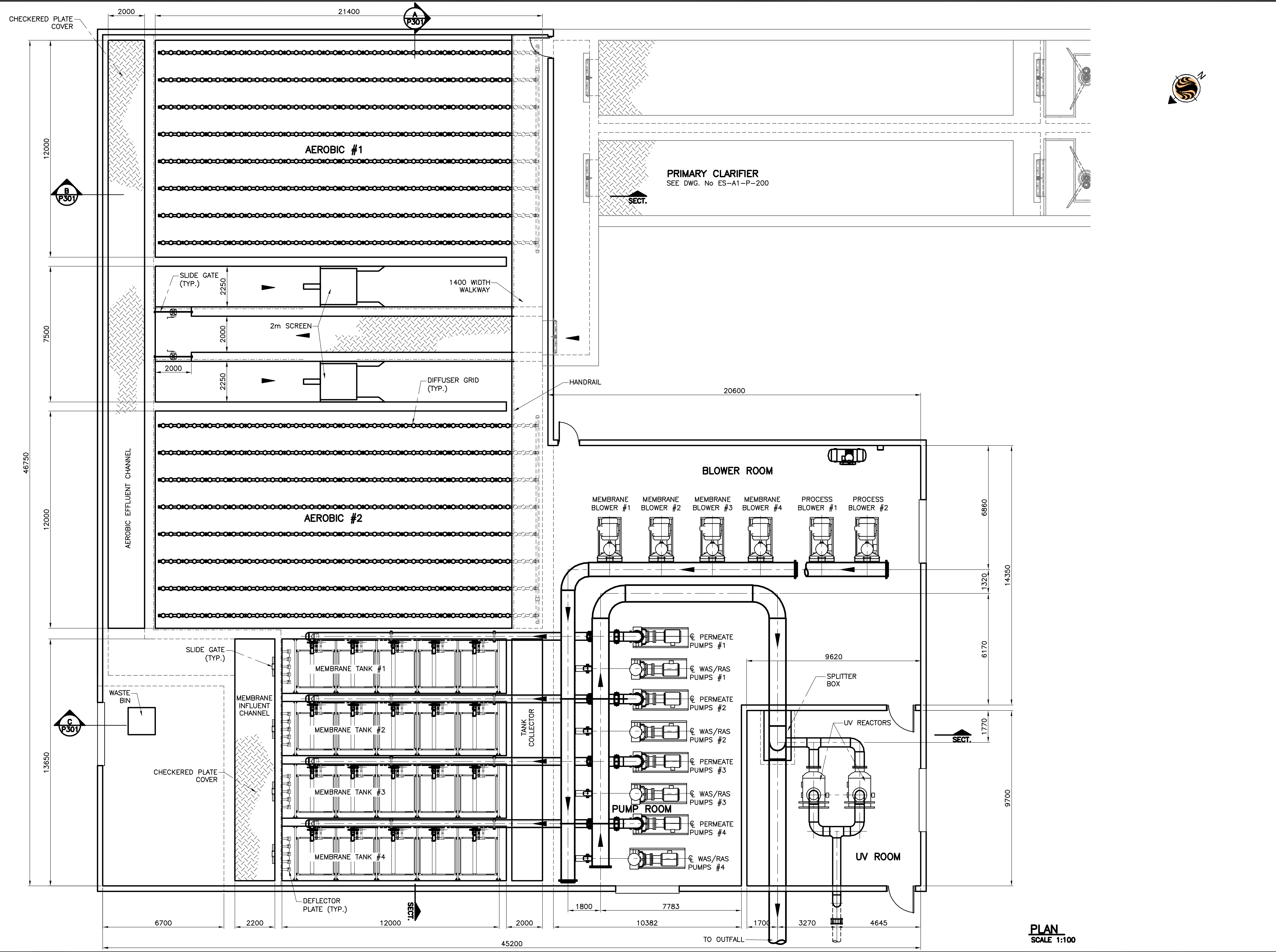
SCALE VERTICAL –	APPROVED RAF

CORE AREA WASTEWATER TREATMENT PROGRAM

SAANICH EAST SITE
OPTION 1A
HIGH RATE PRIMARY CLARIFIERS (LAMELLA PLATE) WITH CEP
GENERAL ARRANGEMENT – SECTIONS

CONTRACT NUMBER – | DRAWING NUMBER ES-A1-P-201 | ISSUE – | SHT. No. – OF –



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SCALE VERTICAL	–	APPROVED	RAF

CORE AREA WASTEWATER TREATMENT PROGRAM

SAANICH EAST SITE
OPTION 1A
MEMBRANE BIOREACTOR SECONDARY TREATMENT
GENERAL ARRANGEMENT–PLAN

CONTRACT NUMBER –   DRAWING NUMBER ES–A1–P–300   ISSUE –   SHT. No. – OF –

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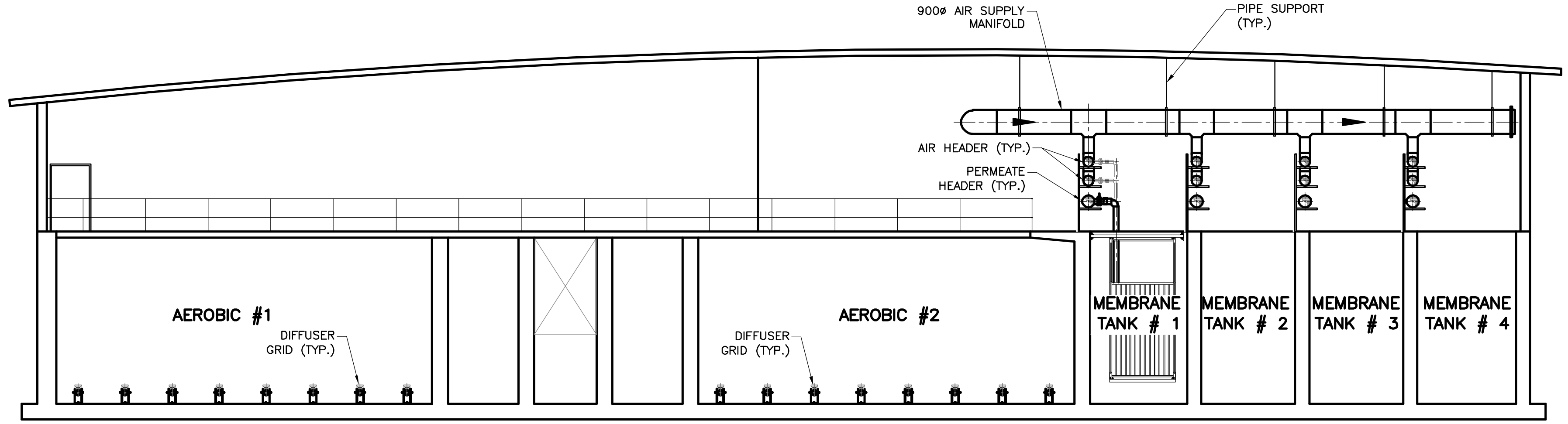

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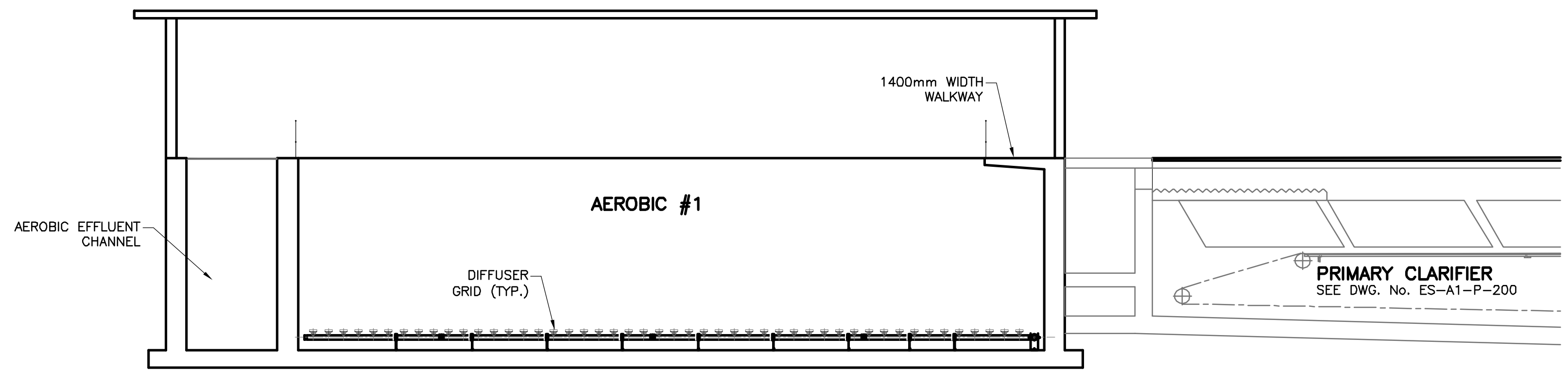

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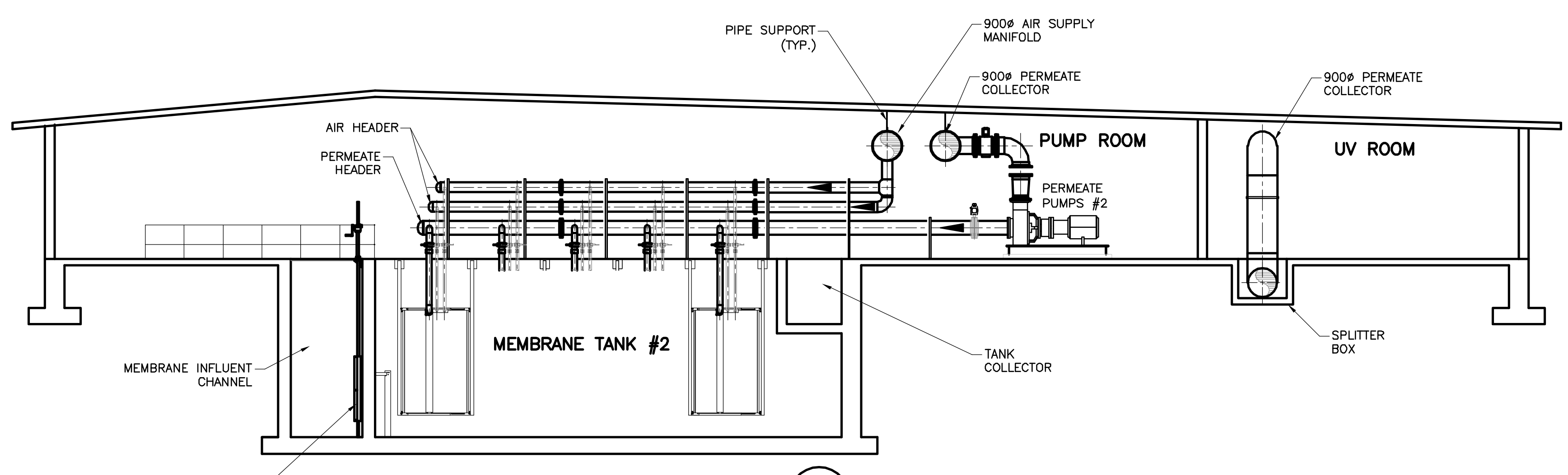

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November 20, 2009 9:53 a.m.

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DRAWN	PRC	DATE	08/12/09
SCALE HORIZONTAL	1:100	CHECKED	PP
SCALE VERTICAL	–	APPROVED	RAF

CORE AREA WASTEWATER TREATMENT PROGRAM
SAANICH EAST SITE
OPTION 1A
MEMBRANE BIOREACTOR SECONDARY TREATMENT
SECTIONS

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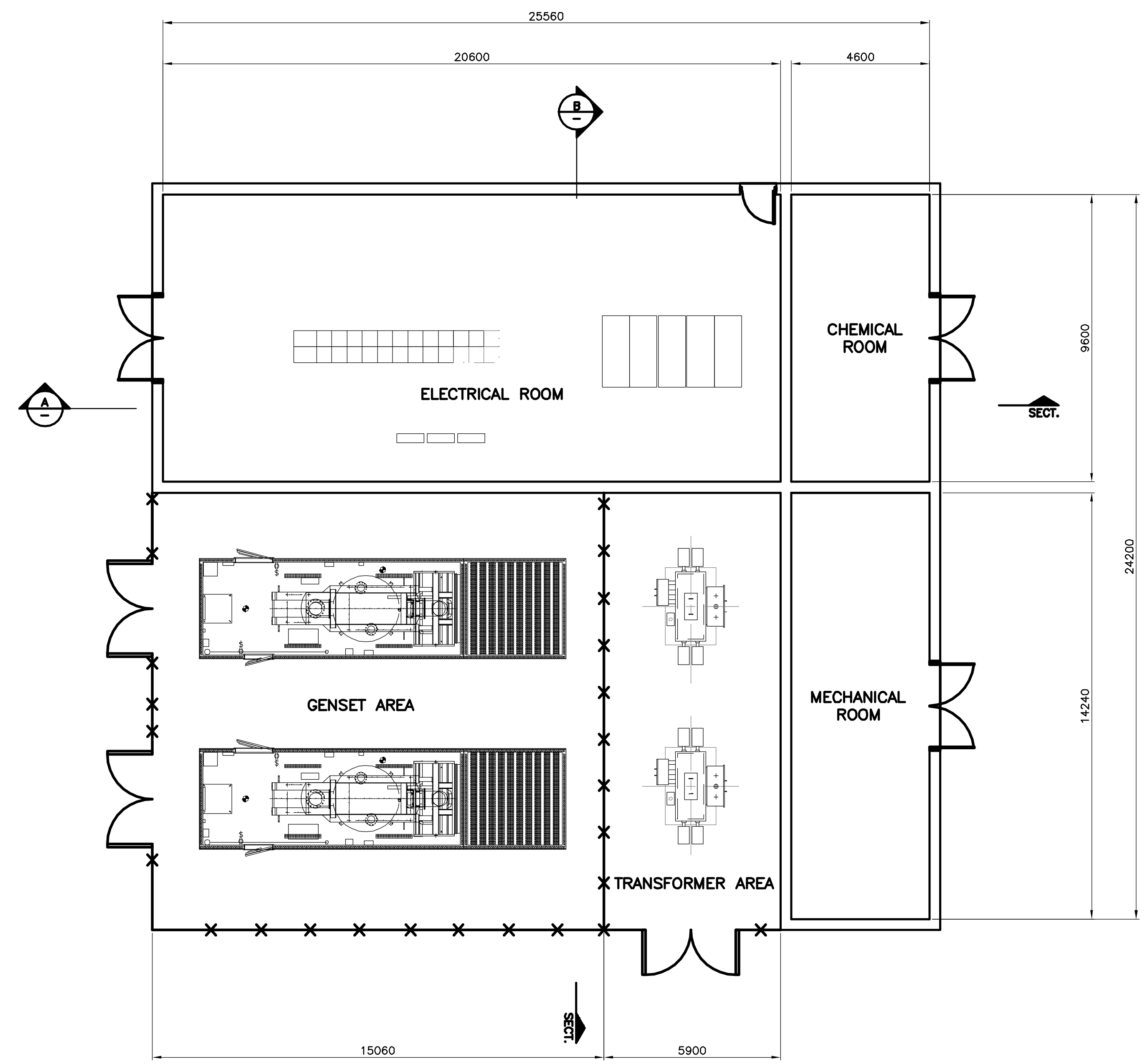

PLAN
SCALE 1:100

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November 20, 2009 9:55 a.m.

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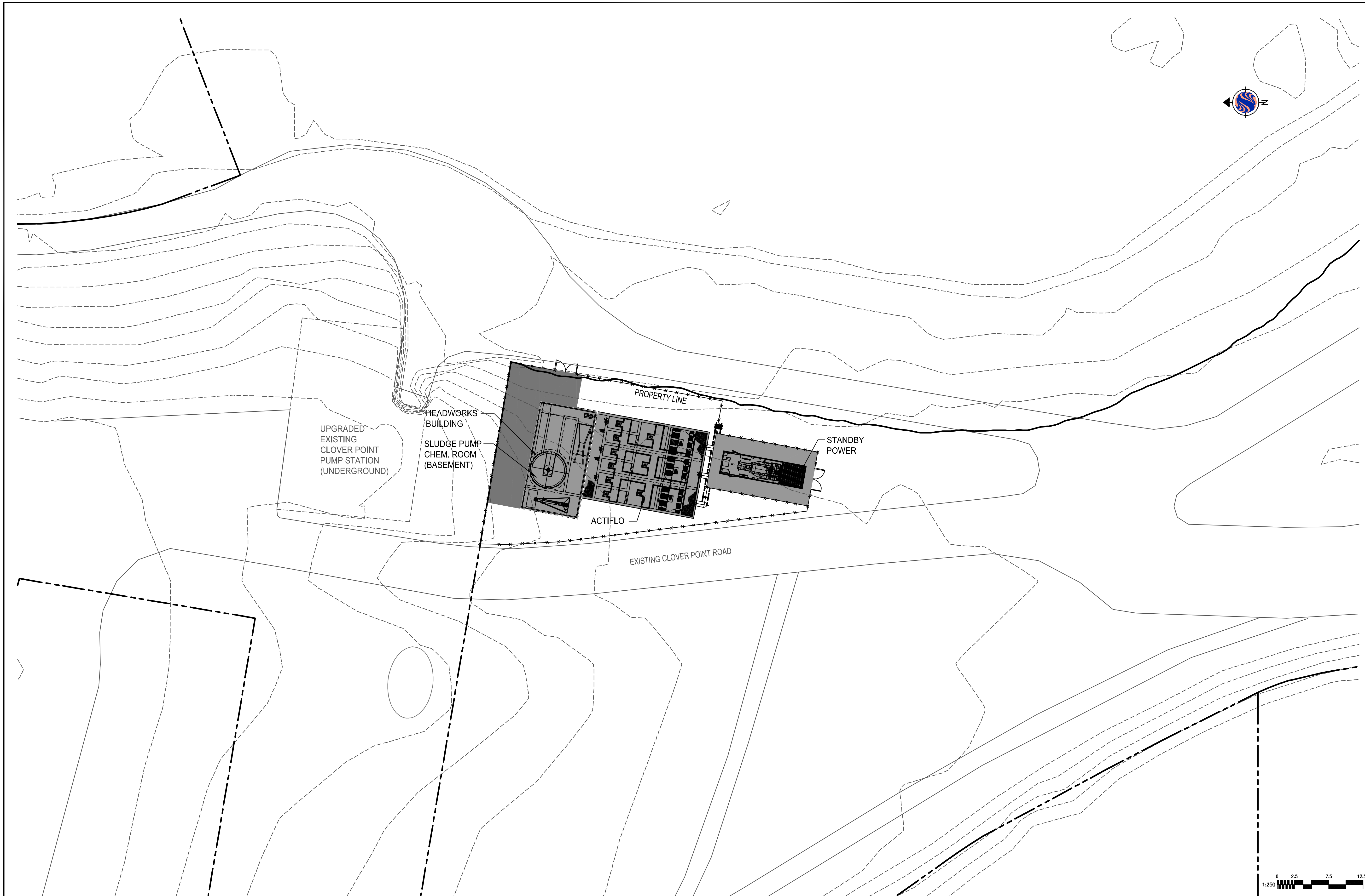
DRAWN PRC	DATE 08/12/09
SCALE HORIZONTAL 1:100	CHECKED PP
SCALE VERTICAL –	APPROVED RAF

CORE AREA WASTEWATER TREATMENT PROGRAM

SAANICH EAST SITE
OPTION 1A
AUXILLIARY BUILDING
GENERAL ARRANGEMENT–PLAN

CONTRACT NUMBER	DRAWING NUMBER	ISSUE	SHT. No. OF
–	ES–A1–P–500	–	– OF –



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DRAWN	PRC	DATE	08/12/09
SCALE HORIZONTAL	1:250	CHECKED	PP
SCALE VERTICAL	–	APPROVED	RAF

CORE AREA WASTEWATER TREATMENT PROGRAM

CLOVER POINT SITE
OPTION 1A
WET WEATHER TREATMENT FACILITY
SITE PLAN

CONTRACT NUMBER – | DRAWING NUMBER CL–A–C–010 | ISSUE – | SHT. No. – OF –

(Major equipment is designed for year 2030 flow which is higher than year 2065 flow)	
	Option 1A
Design Parameters	**Clover Wet Weather Wastewater Treatment Plant**
Year 2030 ADWF (ML/d)	37.79
Year 2065 ADWF (ML/d)	37.05
Existing Clover Point Pump Station Upgrade for pumping to McLoughlin and to Actiflo Units:	
Total New Pumping Capacity (ML/d)	75.6
No. of New Pumps (including One Standby)	2
Forceman Diameter (mm)	900
Headworks:	
Existing Screening Hydraulic Capacity (ML/d)	403
No. of Existing Screens with Compactors	2
Existing Screen Size (mm)	6
Vortex Grit Removal Capacity (ML/d)	75.6
No. of Vortex Grit Chambers	1
Diameter of Vortex Grit Chamber	5000
No. of Grit Classifiers	1
Actiflo High Rate Primary Clarifier:	
Primary Treatment Capacity (ML/d)	75.6
No. of Primary Clarifier Trains	3
Side Water Depth (m)	3.75
Surface Overflow Rate (m/h)	106
Coagulation Detention Time (sec)	70
Maturation Detention Time (sec)	150
Outfall:	
Existing Clover Point Outfall Diameter (mm)	1050
Existing Outfall Length (m)	1154

Xrefs: A1-CRD-TITLE.DWG;
Drawing: V:\1490\149009002\DRAWINGS\OPTION 1A\CL-A-G-010.DWG
November 16, 2009 12:46 p.m.

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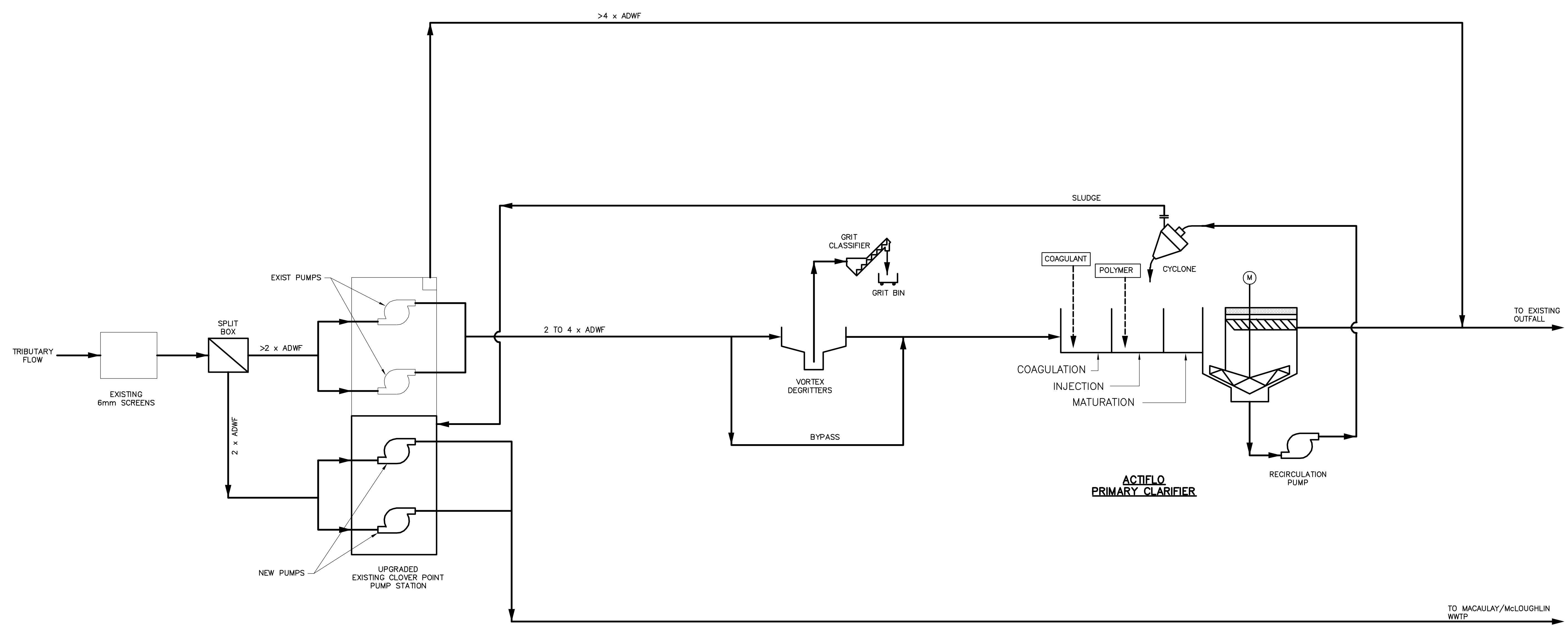
DRAWN PRC	DATE 08/12/09		
SCALE HORIZONTAL –	CHECKED PP		
SCALE VERTICAL –	APPROVED RAF		

CORE AREA WASTEWATER TREATMENT PROGRAM

CLOVER POINT SITE
OPTION 1A
WET WEATHER TREATMENT FACILITY
DESIGN CRITERIA

CONTRACT NUMBER – DRAWING NUMBER CL-A-G-010 ISSUE – SHT. No. – OF –



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November 13, 2009 12:23 p.m.

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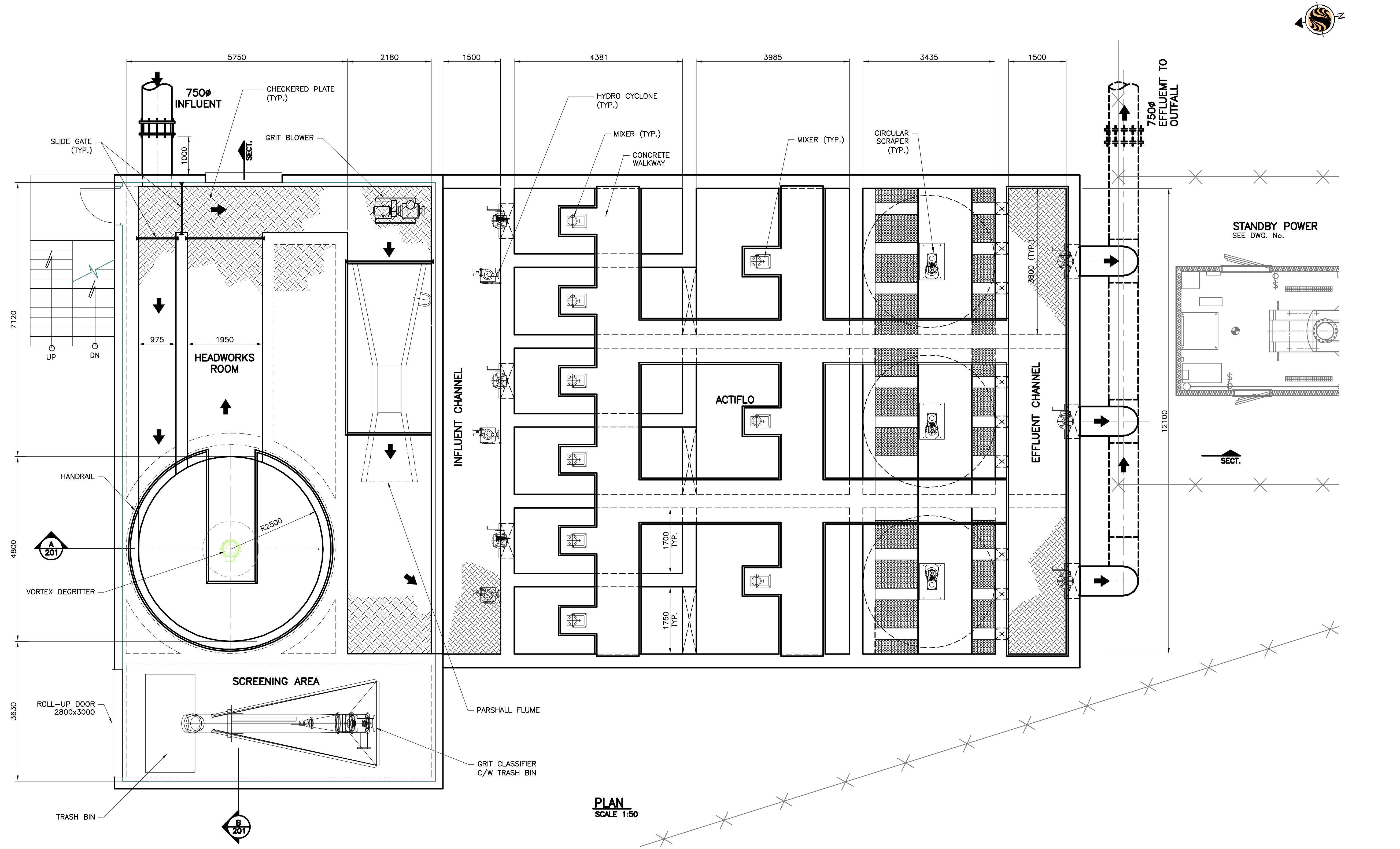
DRAWN	PRC	DATE	08/12/09
SCALE HORIZONTAL	–	CHECKED	PP
SCALE VERTICAL	–	APPROVED	RAF

CORE AREA WASTEWATER TREATMENT PROGRAM

CLOVER POINT SITE
OPTION 1A
WET WEATHER TREATMENT FACILITY
PROCESS FLOW DIAGRAM

CONTRACT NUMBER – DRAWING NUMBER CL-A-G-015 ISSUE – SHT. No. – OF –



PLAN
SCALE 1:50

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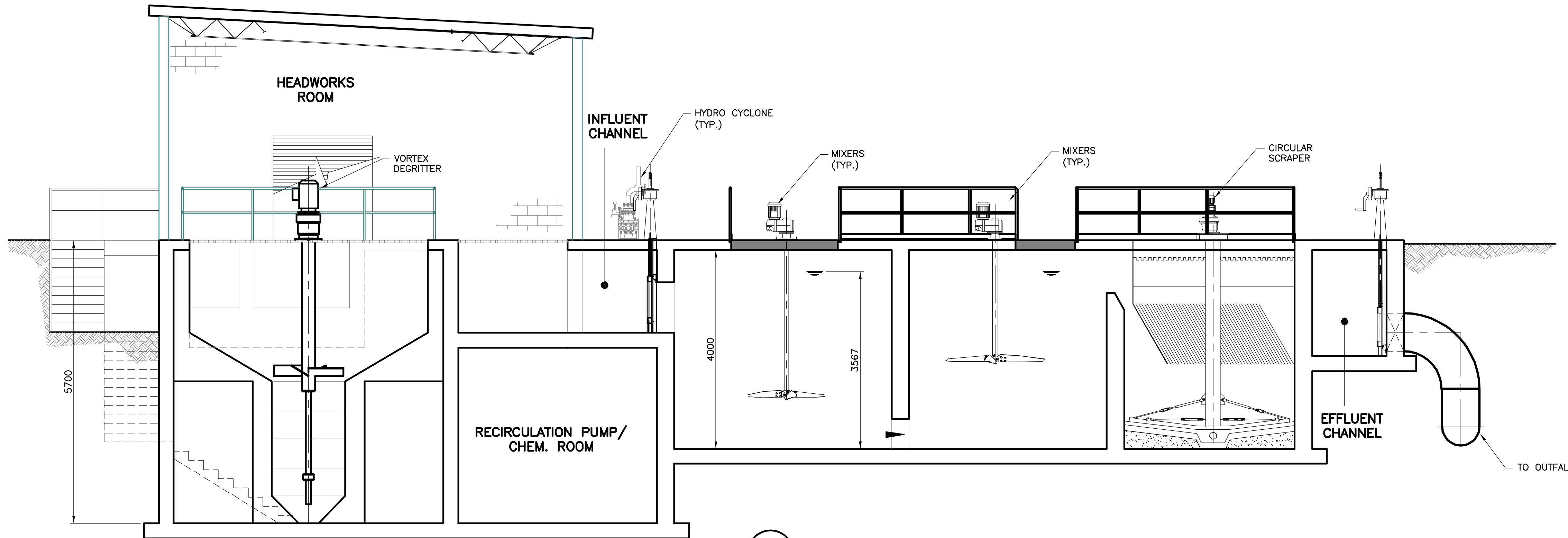
SCALE HORIZONTAL	–	CHECKED	PP
SCALE VERTICAL	–	APPROVED	RAF

CORE AREA WASTEWATER TREATMENT PROGRAM
CLOVER POINT SITE
OPTION 1A
HEADWORKS/ACTIFLO
PLAN

CONTRACT NUMBER –
DRAWING NUMBER CL–A–P–200
ISSUE –
SHT. No. – OF –



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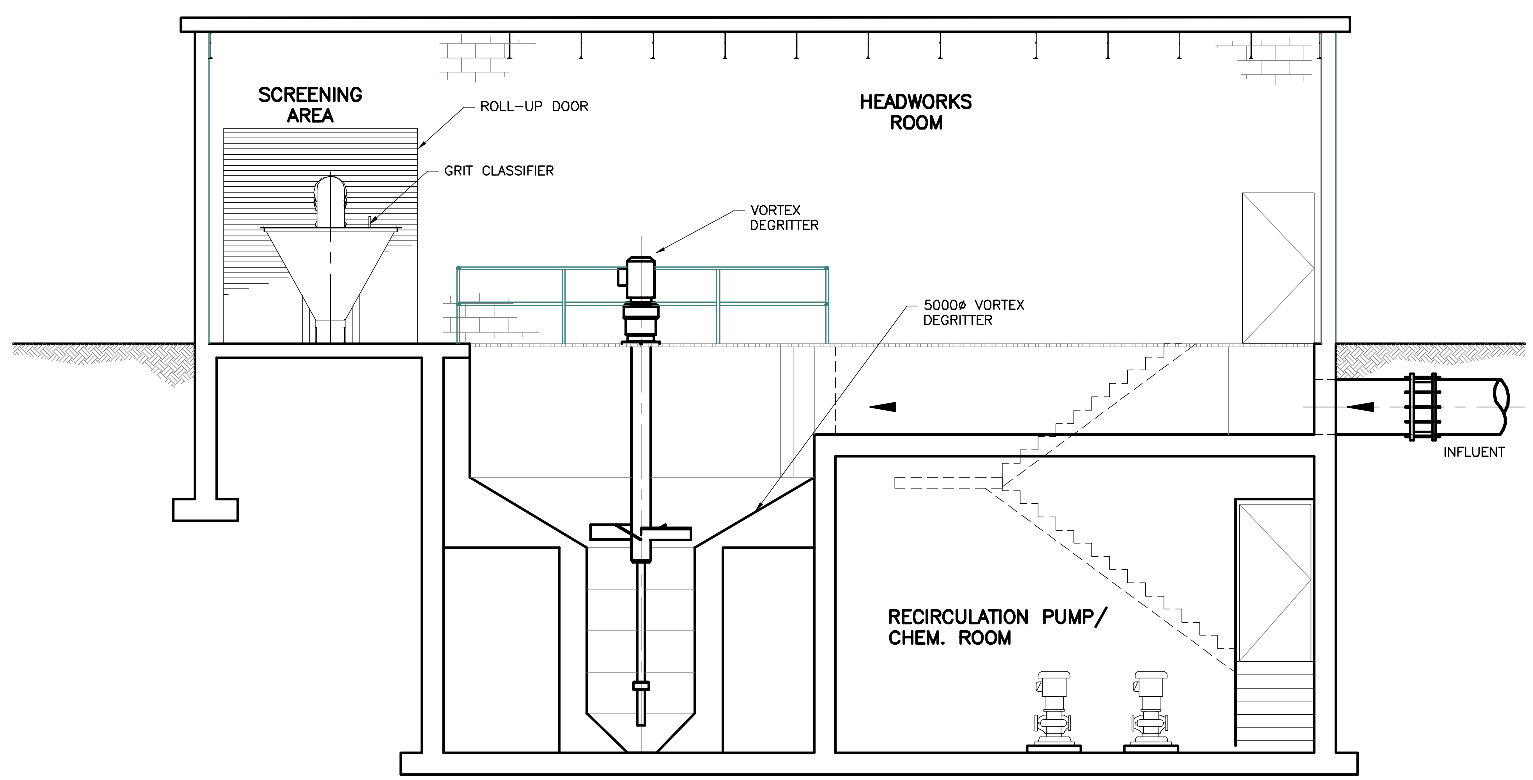

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November 13, 2009 12:24 p.m.

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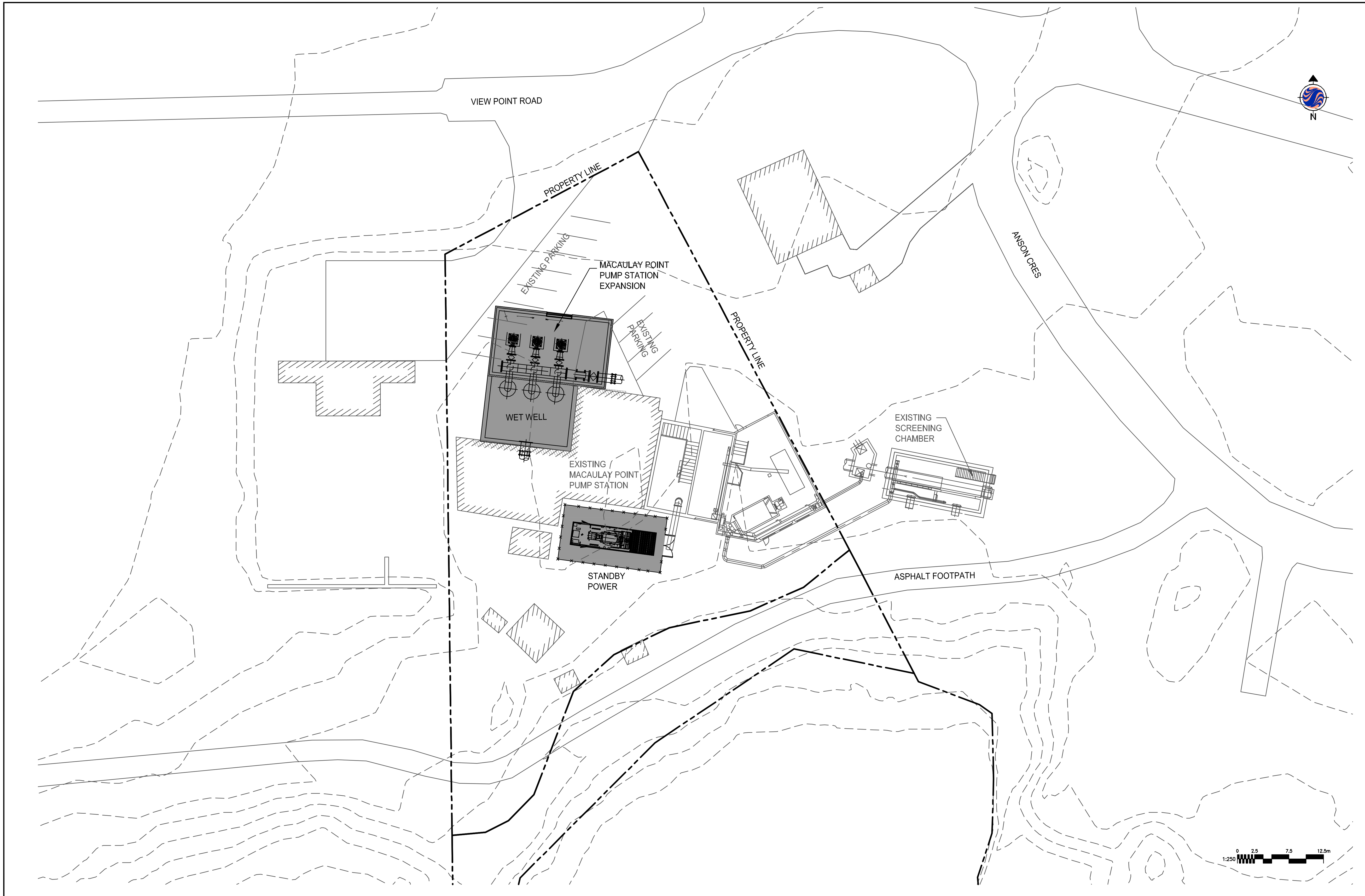
SCALE HORIZONTAL	–	CHECKED	PP
SCALE VERTICAL	–	APPROVED	RAF

CORE AREA WASTEWATER TREATMENT PROGRAM

CLOVER POINT SITE
OPTION 1A
HEADWORKS/ACTIFLO
SECTIONS

CONTRACT NUMBER – | DRAWING NUMBER CL–A–P–201 | ISSUE – | SHT. No. – OF –



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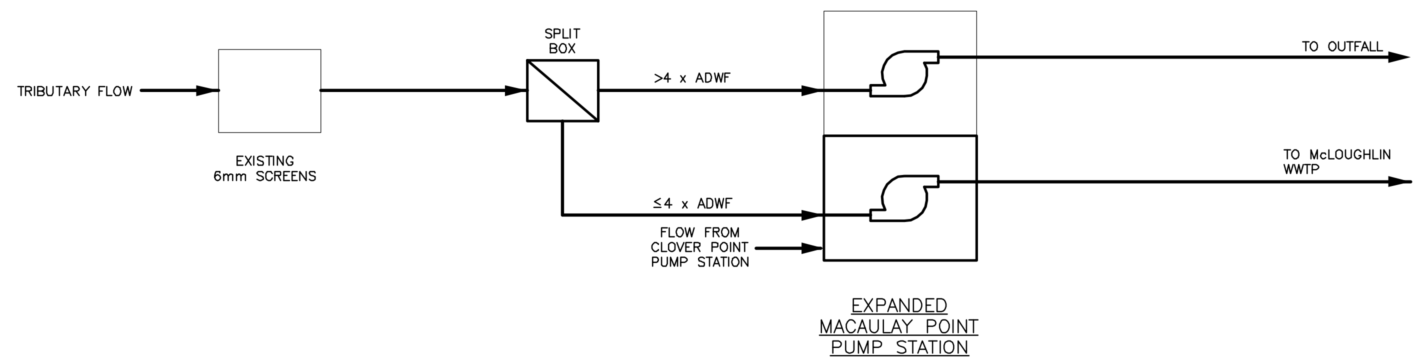
CORE AREA WASTEWATER TREATMENT PROGRAM

MACAULAY PT. SITE
OPTION 1A
PUMP STATION EXPANSION
SITE PLAN

CONTRACT NUMBER – | DRAWING NUMBER MC–A1–C–010 | ISSUE – | SHT. No. – OF –



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CORE AREA WASTEWATER TREATMENT PROGRAM

MACAULAY POINT SITE
OPTION 1A
PUMP STATION EXPANSION
PROCESS FLOW DIAGRAM

CONTRACT NUMBER – | DRAWING NUMBER MC-A-G-015 | ISSUE – | SHT. No. – OF –

Xrefs: A1-CRD-TITLE.DWG; xref_PFD.DWG; ml-ac-pumpstation.DWG;
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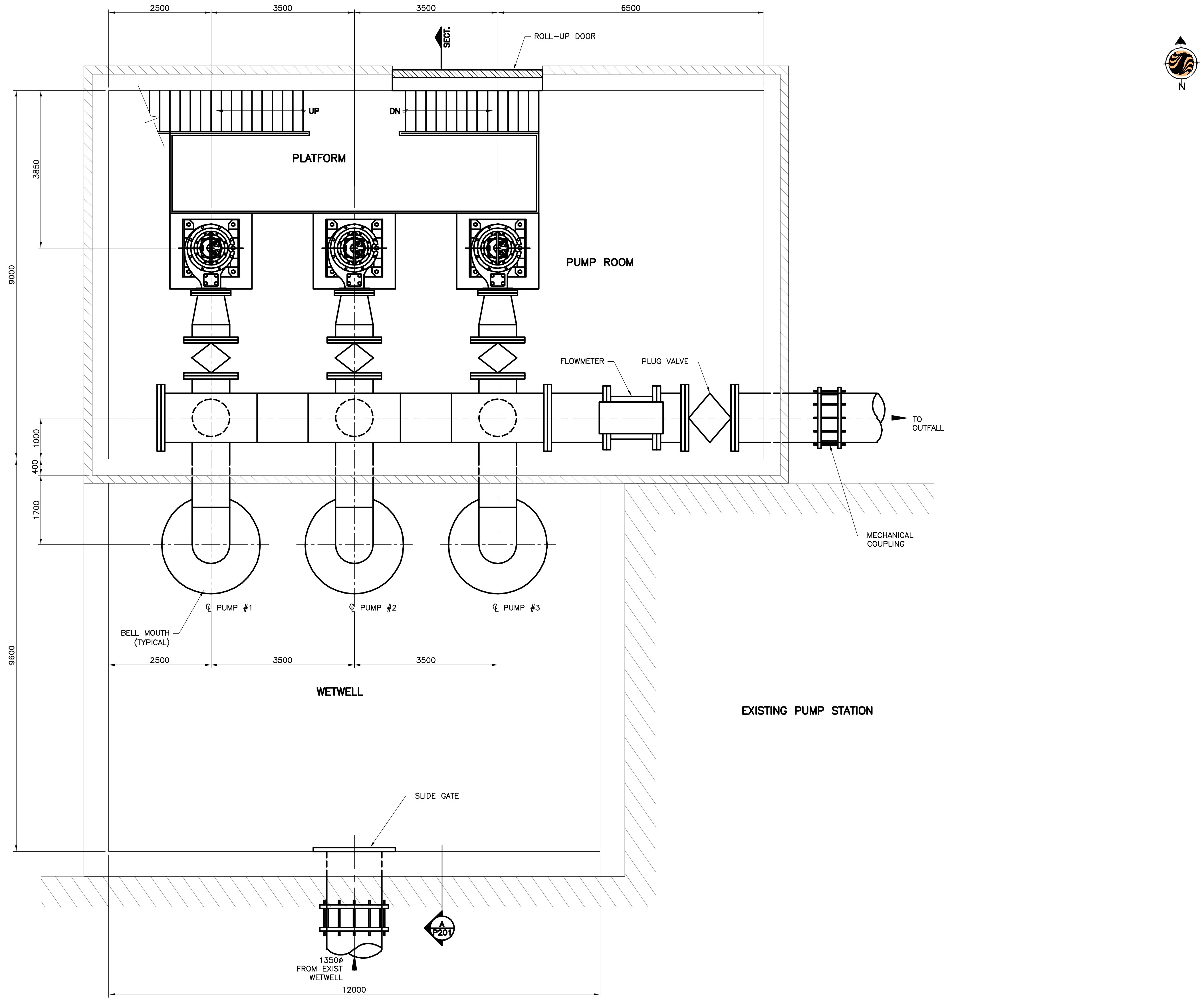

PLAN
SCALE 1:50

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November 20, 2009 10:29 a.m.

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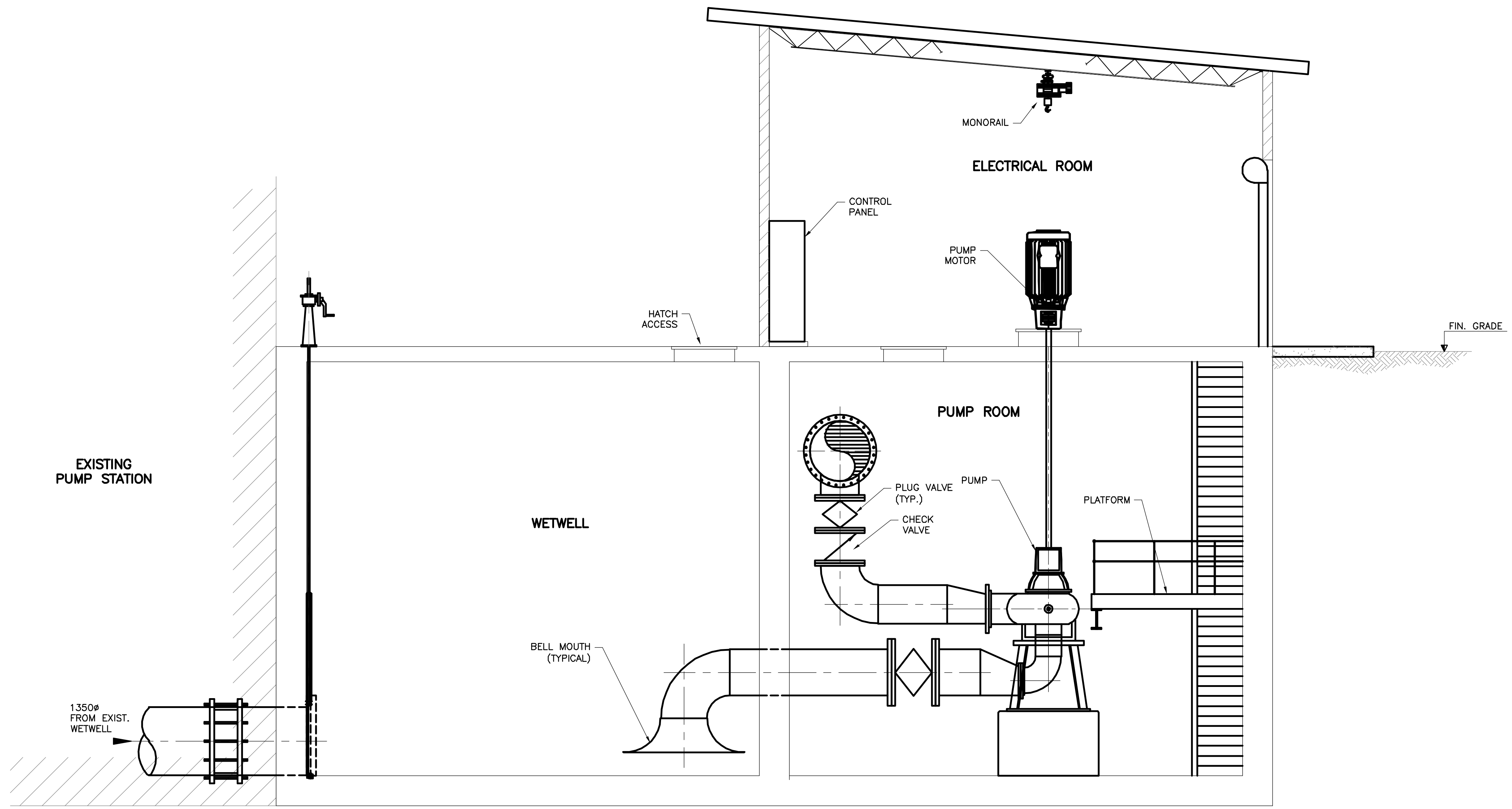
SCALE VERTICAL –	APPROVED RAF

CORE AREA WASTEWATER TREATMENT PROGRAM

MACAULAY POINT SITE
OPTION 1A
PUMP STATION EXPANSION
PLAN

CONTRACT NUMBER	DRAWING NUMBER	ISSUE	SHT. No.
–	MC-A-P-200	–	– OF –



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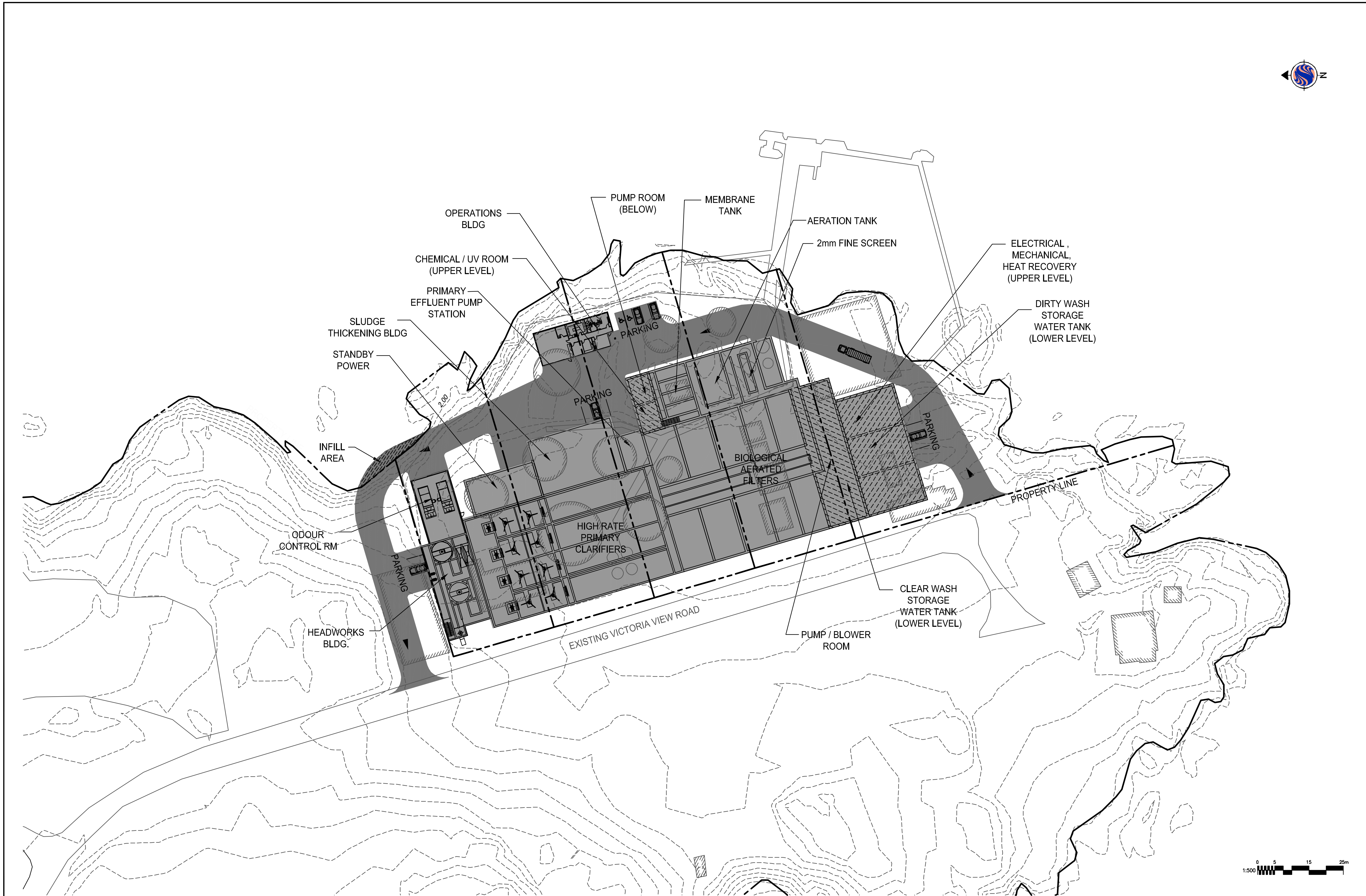
CORE AREA WASTEWATER TREATMENT PROGRAM

MACAULAY POINT SITE
OPTION 1A
PUMP STATION EXPANSION
SECTION

CONTRACT NUMBER – | DRAWING NUMBER MC-A-P-201 | ISSUE – | SHT. No. – OF –



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SCALE VERTICAL	–	APPROVED	RAF

CORE AREA WASTEWATER TREATMENT PROGRAM

Mc LOUGHLIN PT. SITE
OPTION 1A
BAF SECONDARY TREATMENT
SITE PLAN

CONTRACT NUMBER –
DRAWING NUMBER ML–A1–C–010
ISSUE –
SHT. No. – OF –

McLoughlin - Macaulay Point Facilities with BAF Process
(Major equipment is designed for year 2065 flow)

Design Parameters	**Option 1A, Alternative 1 McLoughlin Wastewater Treatment Plant with BAF Process**
Year 2030 ADWF (ML/d) Total	84.15
Year 2030 ADWF (ML/d) Tributary	46.36
Year 2065 ADWF (ML/d) Total	87.48
Year 2065 ADWF (ML/d) Tributary	50.43
Existing Macaulay Point Pump Station Expansion for pumping to McLoughlin WWTP:	
Total Pumping Capacity (ML/d)	276
No. of Pumps (including One Standby)	3
Forceman Diameter (mm)	1800
Headworks:	
Existing Screening Hydraulic Capacity (ML/d)	435
No. of Existing Screens with Compactors	2
Existing Screen Size (mm)	6
Vortex Grit Removal Capacity (ML/d)	276
No. of Vortex Grit Chambers	2
Diameter of Vortex Grit Chamber	6000
No. of Grit Classifiers	1
High Rate Primary Clarifier with Lamella Plates and with CEPT Capability:	
Primary Treatment Capacity (ML/d)	276
No. of Primary Clarifier Trains	4
Type of Clarifier	Rectangular
Side Water Depth (m)	4.5
Surface Overflow Rate (m/h)	13
Lamella Plate Length (m)	3
Lamella Spacing (mm)	75
Lamella Plate Angle to Horizontal (Degree)	55
Lamella Plate Loading Rate (m/d)	32
Rapid Mix Detention Time (sec)	30
Rapid Mix G-Value (s^{-1})	5000
2-stage Flocculation Detention Time (min.)	10
Stage-1 Flocculation G-Value (s^{-1})	75 to 200
Stage-2 Flocculation G-Value (s^{-1})	25 to 100
Coagulant (Alum) Dosage (mg/L)	70 to 80
Coagulant Aid (Polymer) Dosage (mg/L)	1.5
Biological Aeration Filters (BAF):	
Design Hydraulic Capacity (ML/d)	175
No. of Filters	8
Hydraulic Loading Rate (m/h)	4
Organic Loading Rate (kg of BOD/d/m^3 of media)	4.5
Oxygen Requirement (kg of O_2/kg of BOD)	1.6
Oxygen Transfer Rate	12.50%
Media Depth (m)	3.5 to 4.0
Backwash Rate (m/h)	70
Effluent Storage as Percentage of Daily Flow	5%
Tertiary Membrane Filtration for Water Reuse:	
Secondary Treatment Hydraulic Capacity (ML/d)	12
No. of Membrane Trains	1
Water Depth (m)	5.5

Membrane Tank Volume (m^3)	360
Design HRT (h)	3.5
Disinfection for Water Reuse:	
Design Flow for Water Reuse (ML/d)	12
No. of UV Reactors	2
Reactor Flange Size (mm)	500
Minimum UV Transmittance	70%
Maximum Total Suspended Solids (mg/L)	5
Design UV Dose (mJ/cm^2)	80
Disinfection Limit (Fecal Coliform MPN / 100 ml)	2.2
Sodium Hypochlorite Solution Concentration	12%
Disinfection for Secondary Effluent:	
Design Flow (ML/d)	276
No. of UV Channels	2
No. of UV Banks	4
Minimum UV Transmittance	60%
Maximum Total Suspended Solids (mg/L)	30
Design UV Dose (mJ/cm^2)	24000
Disinfection Limit (Fecal Coliform MPN / 100 ml)	200
Drum Rotary Thickener (DRT):	
Biosolids (kg/d)	29300
No. of Thickeners	3
Drum Thickener Capacity per Unit (gpm)	500
Diameter (mm)	1500
Length (mm)	3000
Outfall:	

Design and Operating Criteria for Victoria Biosolids Center (Hartland Landfill Site)

Parameter	Option 1A McLoughlin
Sludge Screening	
Number of Screens	2
Capacity, each, m^3/day	2,200
Capacity, each, m^3/day	2,200
FOG Receiving Facility	
Number of Screens	1
Capacity, each, m^3/day	2,200
Number of storage tanks	2
Tank volume, each, m^3	28
Anaerobic Digestion and Performance Criteria	
Digesters	
Total Firm Capacity, m^3 (with one offline)	10,800
Number of digesters	4
Capacity each, m^3	3,600
Inside diameter, m	22.9
Side Water Depth, m	9
Cover type	Fixed Cover
Bottom configuration	Cone-bottom
Operating Mode	Class A TPAD
Digester mixing, type	Draft tube, mechanical mixers
Number of Mixers per digester	4
Mixer capacity, l/min each	30,000
Digester heating type	Spiral hot water/sludge HEX
Sludge cooling/heat recovery system	Sludge to Water to Sludge
Transfer system between digestion stages	Standpipes and pump transfer
Digestion Operation/Performance Criteria	
Volatile Solids Load, peak 14-day 3 tanks on-line, kg-VS/m³/day	4.8
Volatile Solids Load to 1st stage thermo, peak 14-day, 2 tanks on-line, kg-VS/m³/day	4.8
Total Solids Loading	
At Ave., kg-TS/day	26,360
At Peak 30-day, kg-TS/day	31,640
At Peak 14-day, kg-TS/day	36,880
Volatile solids reduction	60%
Solids Retention Time, days	
At Peak 14-day, 3 tanks on-line	15
Thermophilic Temp, °C (°F)	~55 (131)
Mesophilic Temp, °C (°F)	~38 (100)
Sludge Blend and Storage Tanks	
Storage Tank Volume, m^3	440
Sludge Blend Tank Volume, m^3	440
Centrifuge Dewatering System	
Centrifuges	
Number	3
Capacity each, m^3/hr	20
Capacity each, l/min	86
Type of machine	High-solids
Centrifuge feed pumps, number	4
Centrifuge feed pump capacity each, l/min	325
Bridge Crane, number	1
Feed concentration, % solids	~2.3
Cake content, % solids	24
Solids capture, %	95
Polymer dose expected, kg/tonne DS	~14
Odor control	FA contain in centrate hopper/biofilter
Foul air capacity, m^3/hr	120
Cake Handling and Loadout	
Classifying screw conveyors, number	3
Cake holding hoppers, number	2
Capacity each, m^3	105
Cake holding time, days (at ave)	2
Number of truck loadout bays	1
Truck weigh scale, number	1
Odor control	FA contain/biofilter
Foul air capacity, m^3/hr	1200

Thermal Solids Drying	
Digested Solids	
At Ave., kg/day dry	12,120
At Peak 30-day, kg/day dry	14,560
Solids Dryers	
Number of units	2
Capacity, each, kg/day dry	7,500
Water Removal, each, kg/day	925
Wet cake contents, % solids	24 %
Dry cake contents, % solids	90 %
Pneumatic Conveyance	
Number	2
Capacity, each, kg/day dry	7,500
Dry Product Storage Silo	
Number	4
Holding Capacity, days	4
Volume, each, m^3	30
Wet Cake Silos	
Number	2
Holding Capacity, days	1
Volume, each, m^3	30
Energy Building	
Boiler	
Number of units	1
Type of boiler	Firetube
Capacity, kW	1,500
Essential Services Generator	
Number of units	1
Type of generator	Diesel
Capacity, kW	300
Diesel Storage Tank	
Number of tanks	1
Type	Double walled above ground fuel storage tank
Capacity, m^3	12
Gas Blowers	
Type, Number of units	Centrifugal, 2
Capacity, N m³/hr	800

Gas Systems	
Gas Production	
Heating value, MJ/m^3 gas	20.9
Des Ave at 60 % VSR, N m³/day	13,517
Des Pk 15-day, 60% VSR, N m³/day	18,924
Gas pressure range from digestion	12 to 20 inches wc
Energy values:	
Des Ave at 60 % VSR, MW	3.432
Des Pk 15-day at 60 % VSR, MW	4.80
Gas Upgrading	
Capacity, N m³/hr	800
Sweetening (H2S Removal)	
Type of System	Sulfatreat
Number of Vessels	2
Compression	
Type, Number	Flooded Screw, 2
Capacity, kW	120, 100
Scrubbing	
Type of System	Pressure Swing Adsorption
Number of Stages	2
Exhaust Gas Blower	
Type, Number	Vacuum Pump, 1
Capacity kW, each	20
Flares	
Number	2
Type of flares	Enclosed
Capacity, each, N m^3/hr	1,500
Odor Control	
Biofilter	
Footprint, m^2	970
Capacity, N m^3/hr	1,450

Assumptions:

The values of food waste production are based on the Metro Vancouver Solid Waste Composition Study -2005.
The production rates of yellow and brown grease are based on Wiltsee (1998) Urban Waste Grease Resource Assessment
The estimated population of CRD for this analysis in 2030 is 355,722 individuals, based on the Core Management and Liquid Assets, dated 2000 and assuming a linear growth rate.
Assumes 0 percent capture of all food waste (commercial and residential) and 50 percent capture of brown and yellow grease which are co-
Brown grease and yellow grease are assumed to be 95 percent volatile with a total solids concentration of 10 percent
Food waste is assumed to be pulped and be 85 percent volatile with a total solids concentration of 10 percent, no additional water added.
Raw sludge prior to digestion is assumed to be 5 percent total solids with a volatile fraction of 82 percent.
A synergistic effect is assumed due to the elevated FOG loads, an additional 2 percentage point increase in sludge volatile solids destructi
The minimum HRT is based on achieving 15 days at the peak 14 day flow and load condition
The organic loading rate (OLR) optimum is based on the digesters size for the given flows and load which achieves the minimum HRT at pe
Assumes a base volatile solids destruction of 60 percent for sewage sludge, 75 percent for food waste and 85 percent for FOG materials
All gas flows normalized at 0 °C and 1 atm.
Minimum winter influent temperatures are assumed to be 12°C
Maximum summer influent temperatures are assumed to be 24°C

Xrefs: A1-CRD-TITLE.DWG;
Drawing: V:\1490\149009002\DRAWINGS\OPTION 1A\ML-A1-G-011.DWG
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CORE AREA WASTEWATER TREATMENT PROGRAM

McLOUGHLIN SITE – HARTLAND LANDFILL SITE
OPTION 1A
DESIGN CRITERIA – BIOSOLIDS

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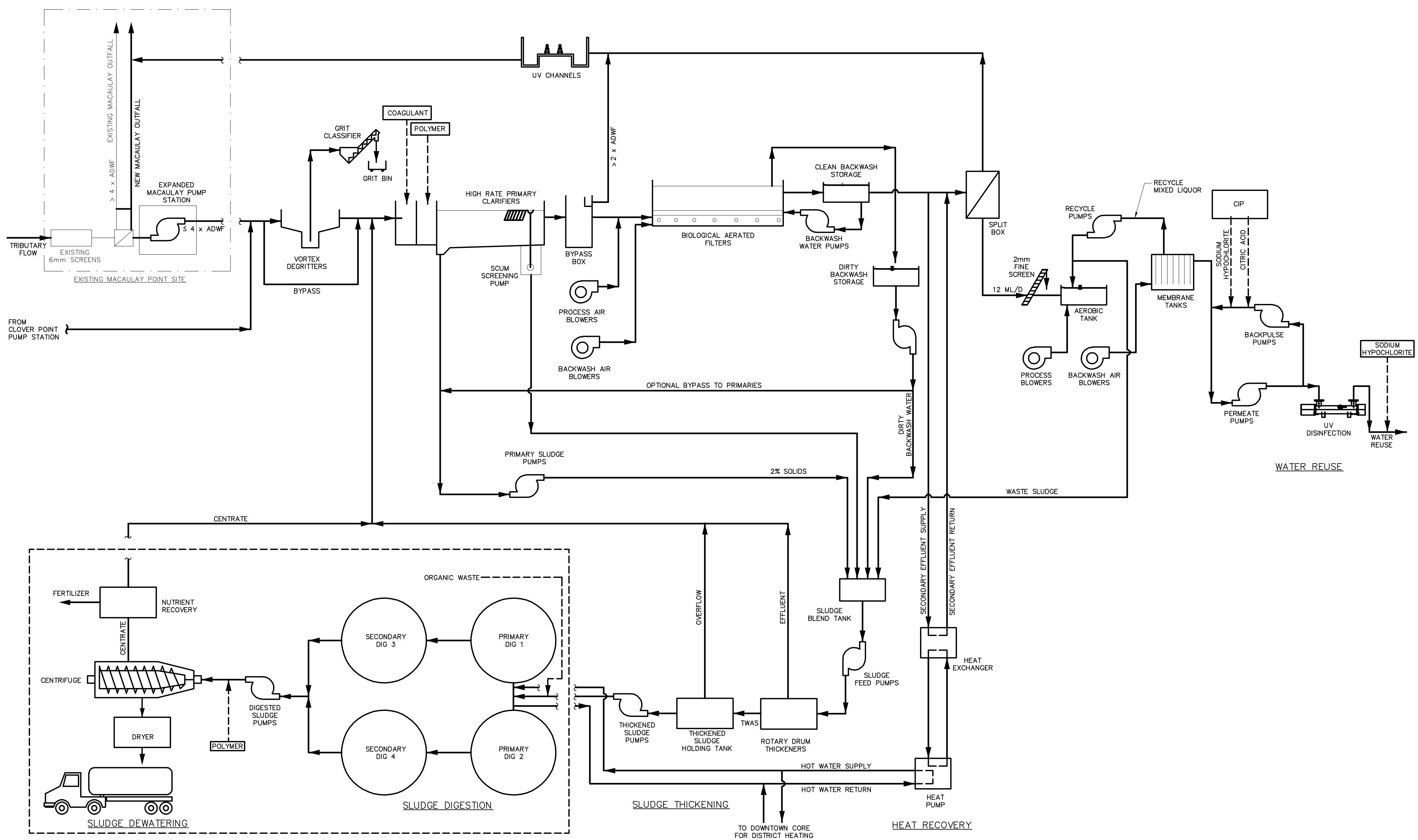

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November 26, 2009 3:12 p.m.

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CORE AREA WASTEWATER TREATMENT PROGRAM

McLOUGHLIN SITE
OPTION 1A

PROCESS FLOW DIAGRAM

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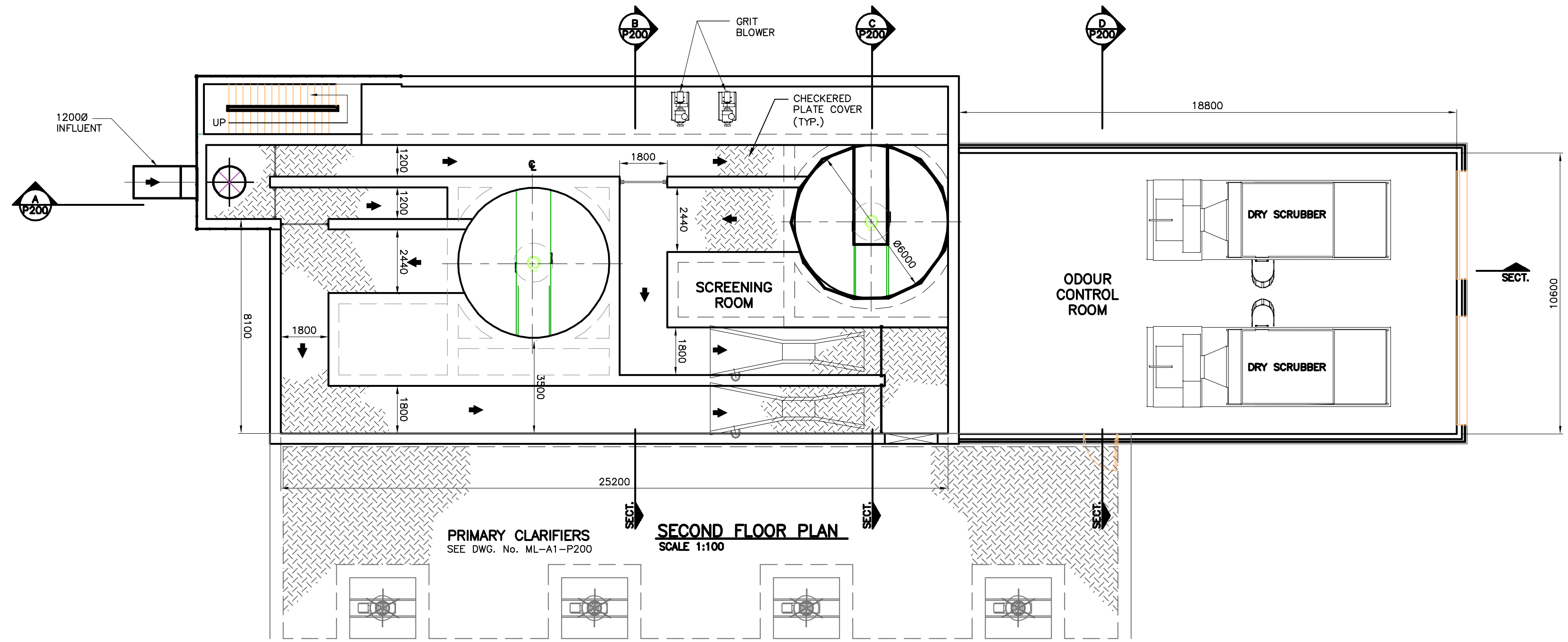

SECOND FLOOR PLAN
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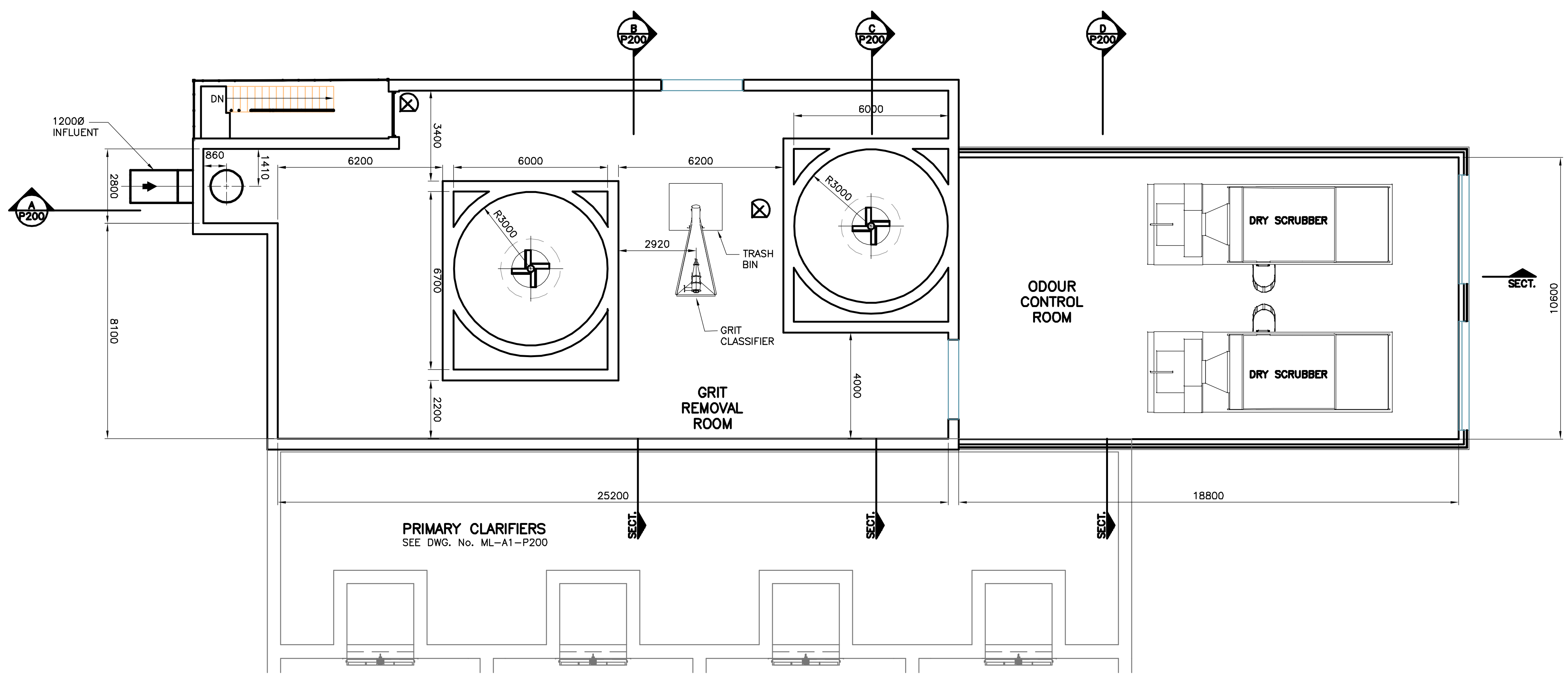

MAIN FLOOR PLAN
SCALE 1:100

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CORE AREA WASTEWATER TREATMENT PROGRAM

McLOUGHLIN SITE
OPTION 1A
HEADWORKS/ODOUR CONTROL
GENERAL ARRANGEMENT – PLAN

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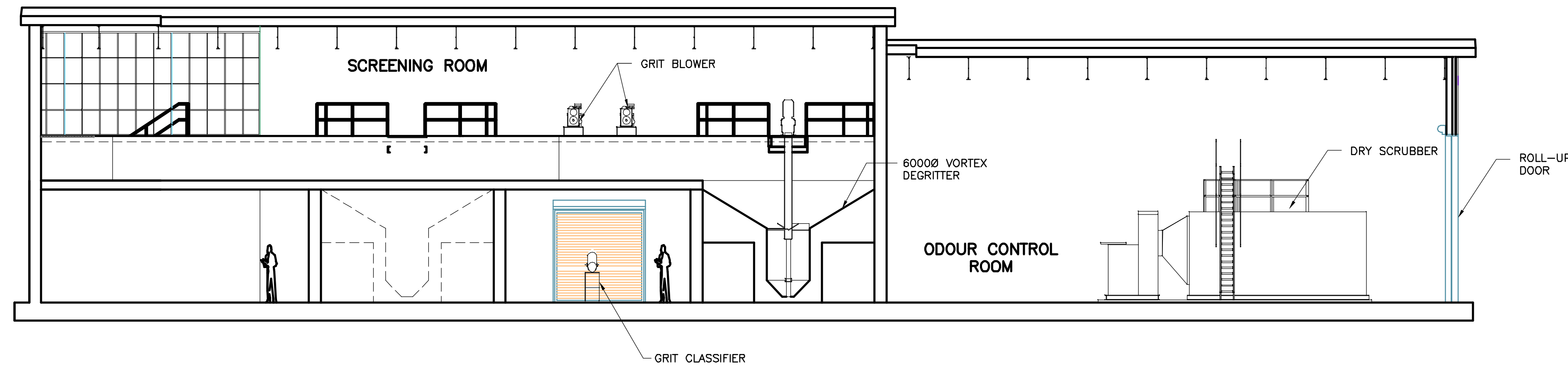

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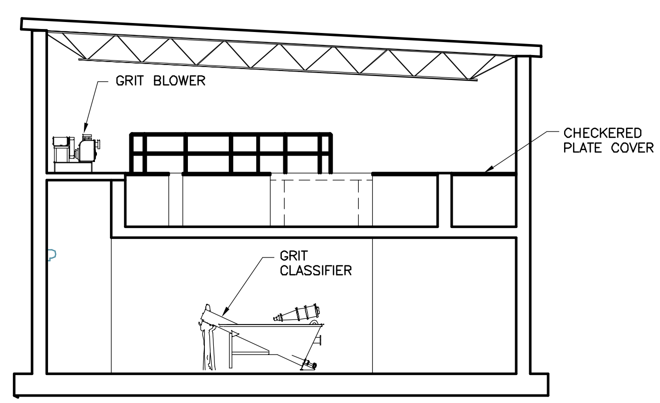

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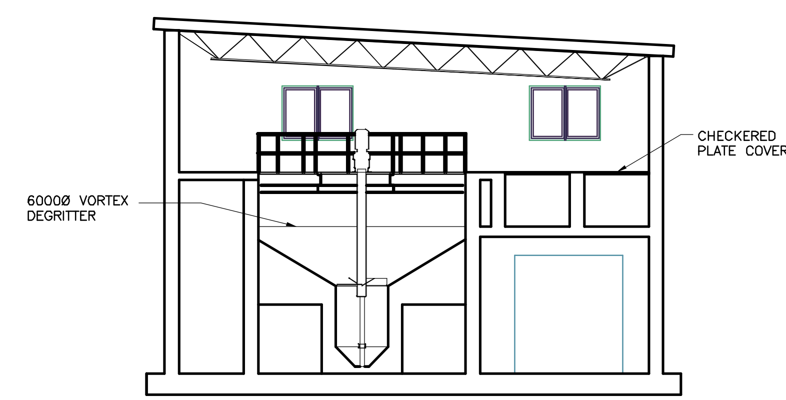

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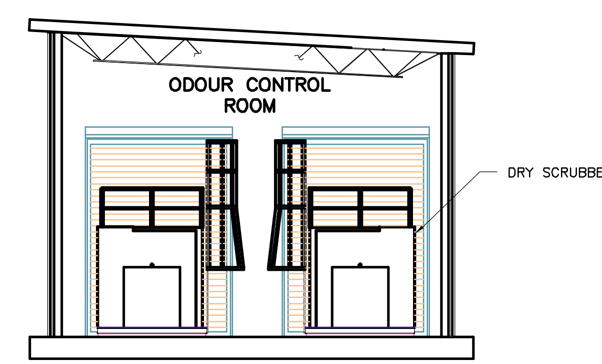

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CORE AREA WASTEWATER TREATMENT PROGRAM

McLOUGHLIN SITE
OPTION 1A
SCREENING\GRIT REMOVAL FACILITY
GENERAL ARRANGEMENT – SECTIONS

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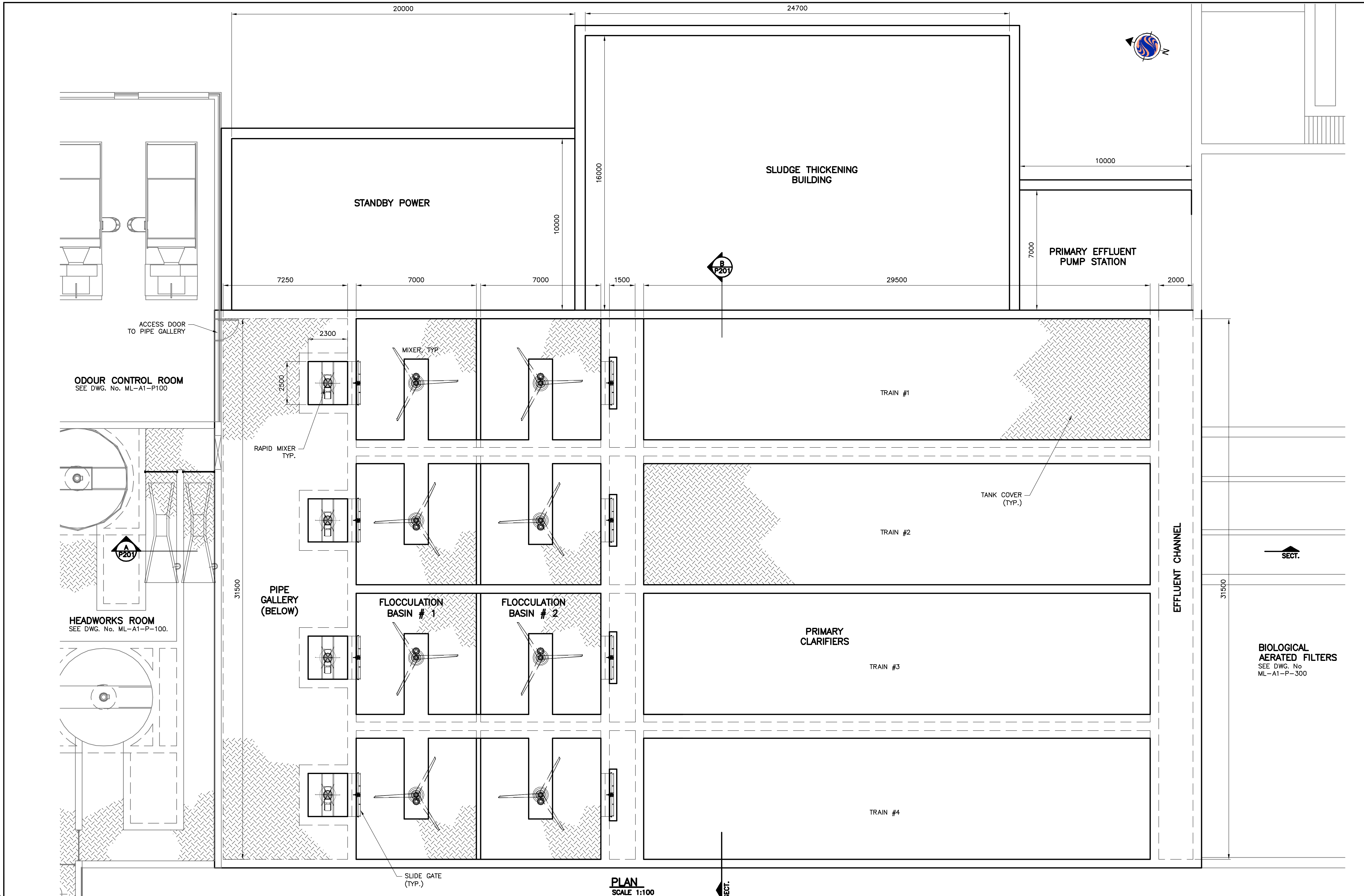

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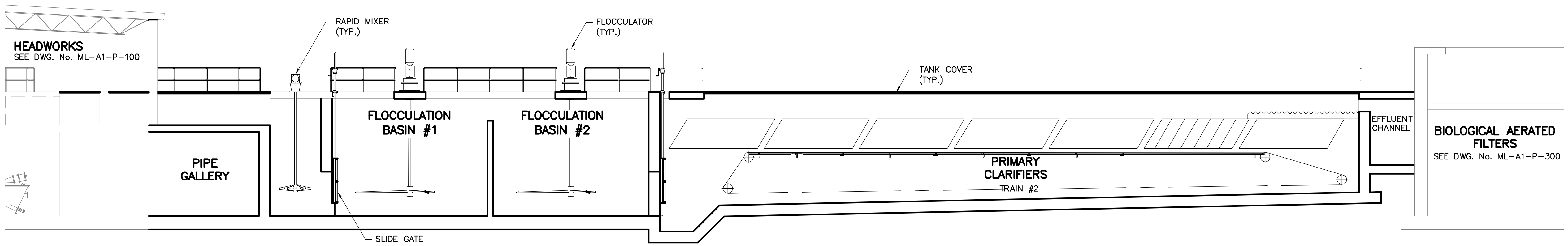
CORE AREA WASTEWATER TREATMENT PROGRAM

Mc LOUGHLIN SITE
OPTION 1A
PRIMARY CLARIFIERS (LAMELLA PLATE) WITH CEP
GENERAL ARRANGEMENT – PLAN

CONTRACT NUMBER –
DRAWING NUMBER ML-A1-P-200
ISSUE –
SHT. No. – OF –



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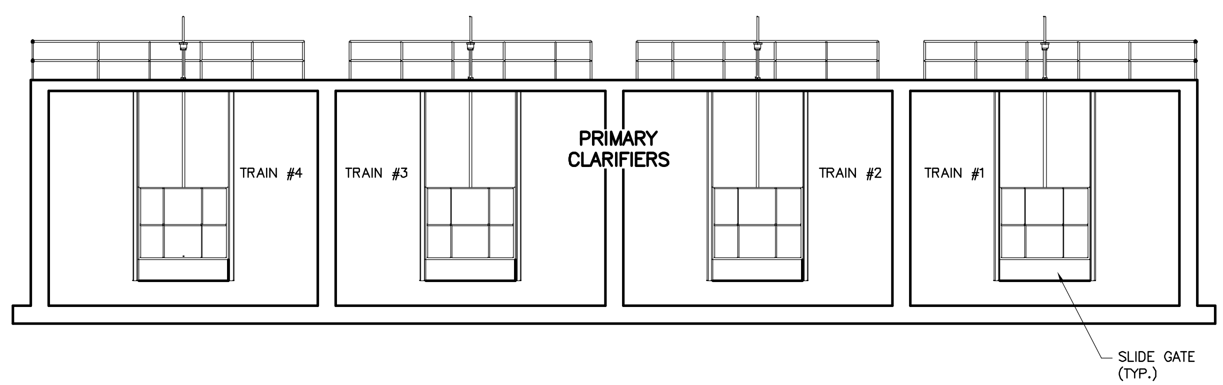

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CORE AREA WASTEWATER TREATMENT PROGRAM

Mc LOUGHLIN SITE
OPTION 1A
PRIMARY CLARIFIERS (LAMELLA PLATE) WITH CEP
GENERAL ARRANGEMENT – SECTIONS

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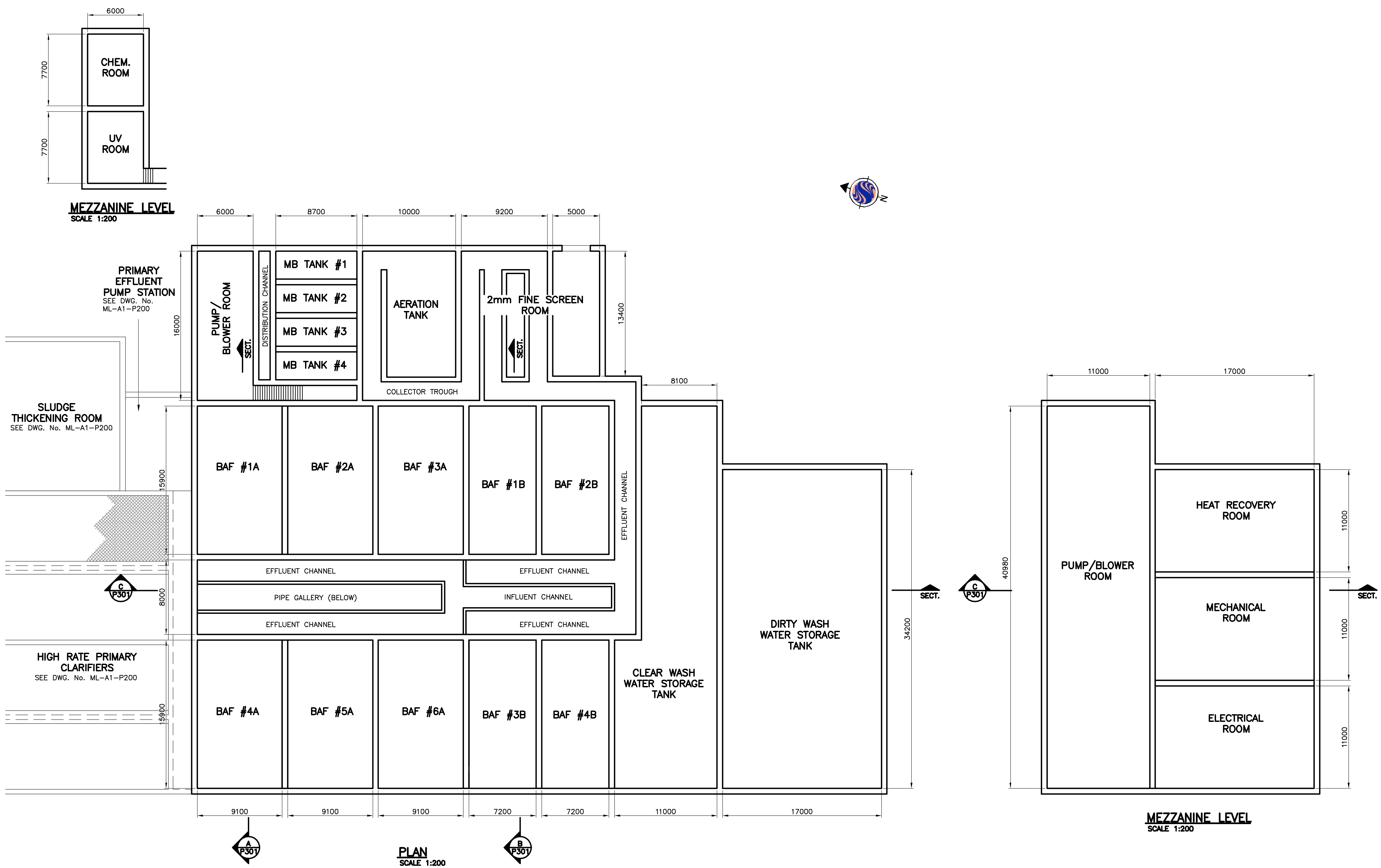
–	ML-A1-P-201	–	– OF –



NOTES:
A FILTERS – 1st STAGE
B FILTERS – 2nd STAGE

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Mc LOUGHLIN SITE
OPTION 1A
BIOLOGICAL AERATED FILTER AND WATER REUSE
GENERAL ARRANGEMENT–PLANS

CONTRACT NUMBER –
DRAWING NUMBER ML-A1-P-300
ISSUE –
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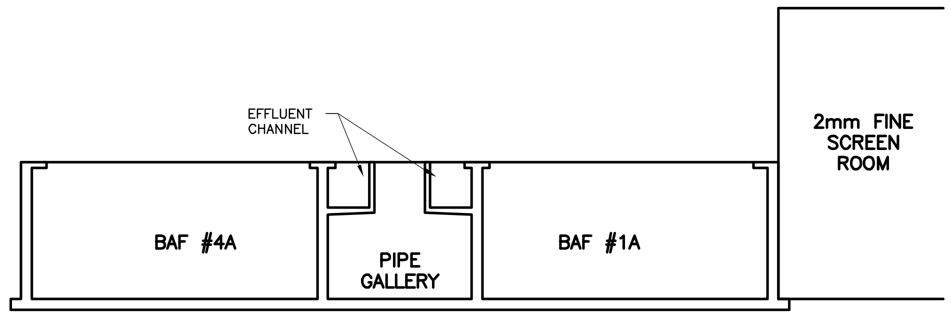

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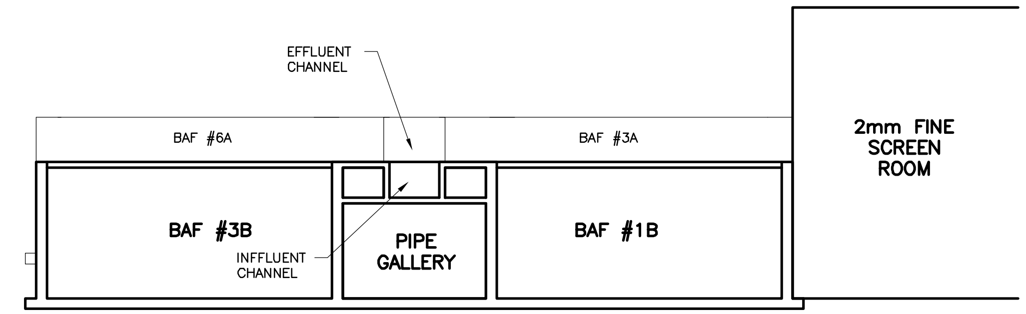

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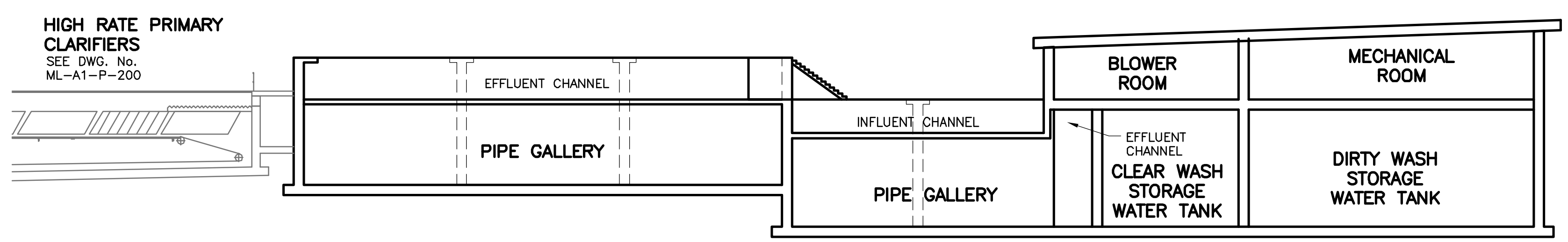

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CORE AREA WASTEWATER TREATMENT PROGRAM
Mc LOUGHLIN SITE
OPTION 1A
BIOLOGICAL AERATED FILTER
SECTIONS

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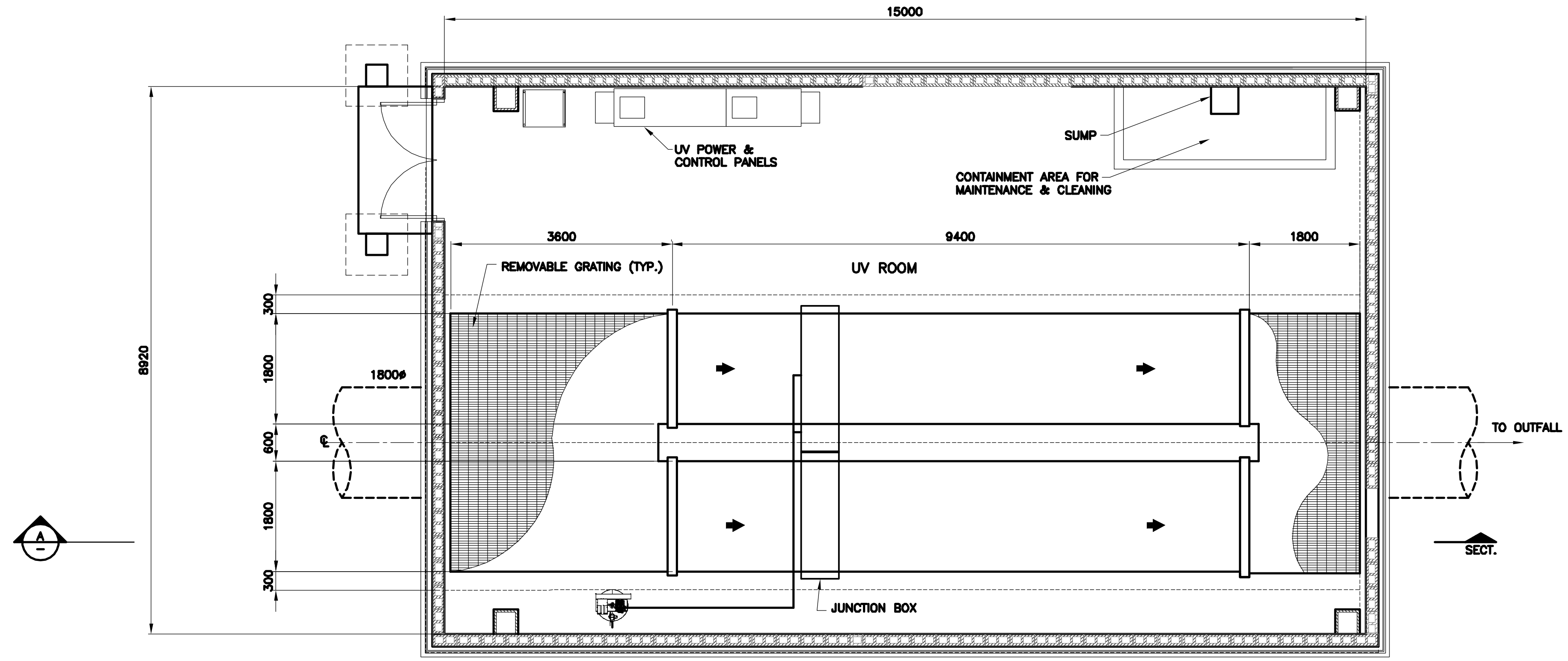

PLAN
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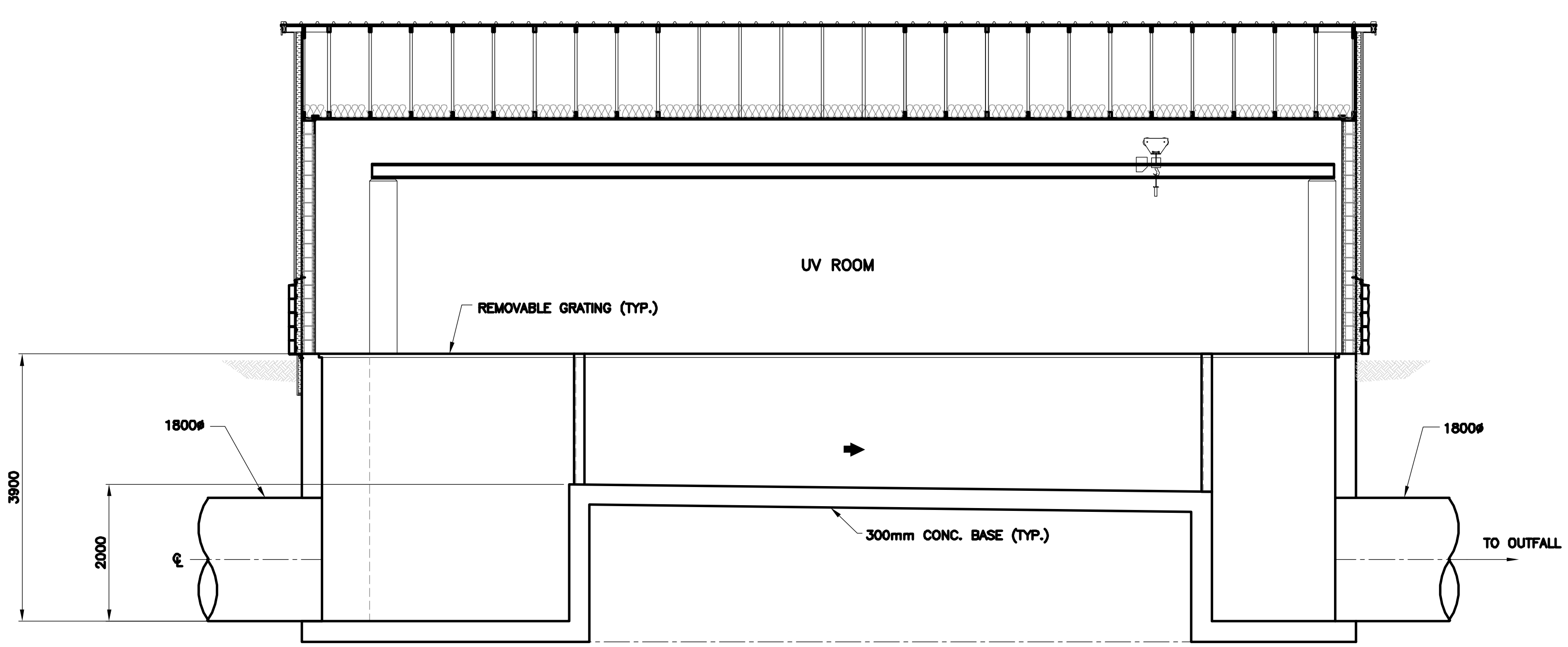

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November 20, 2009 2:17 p.m.

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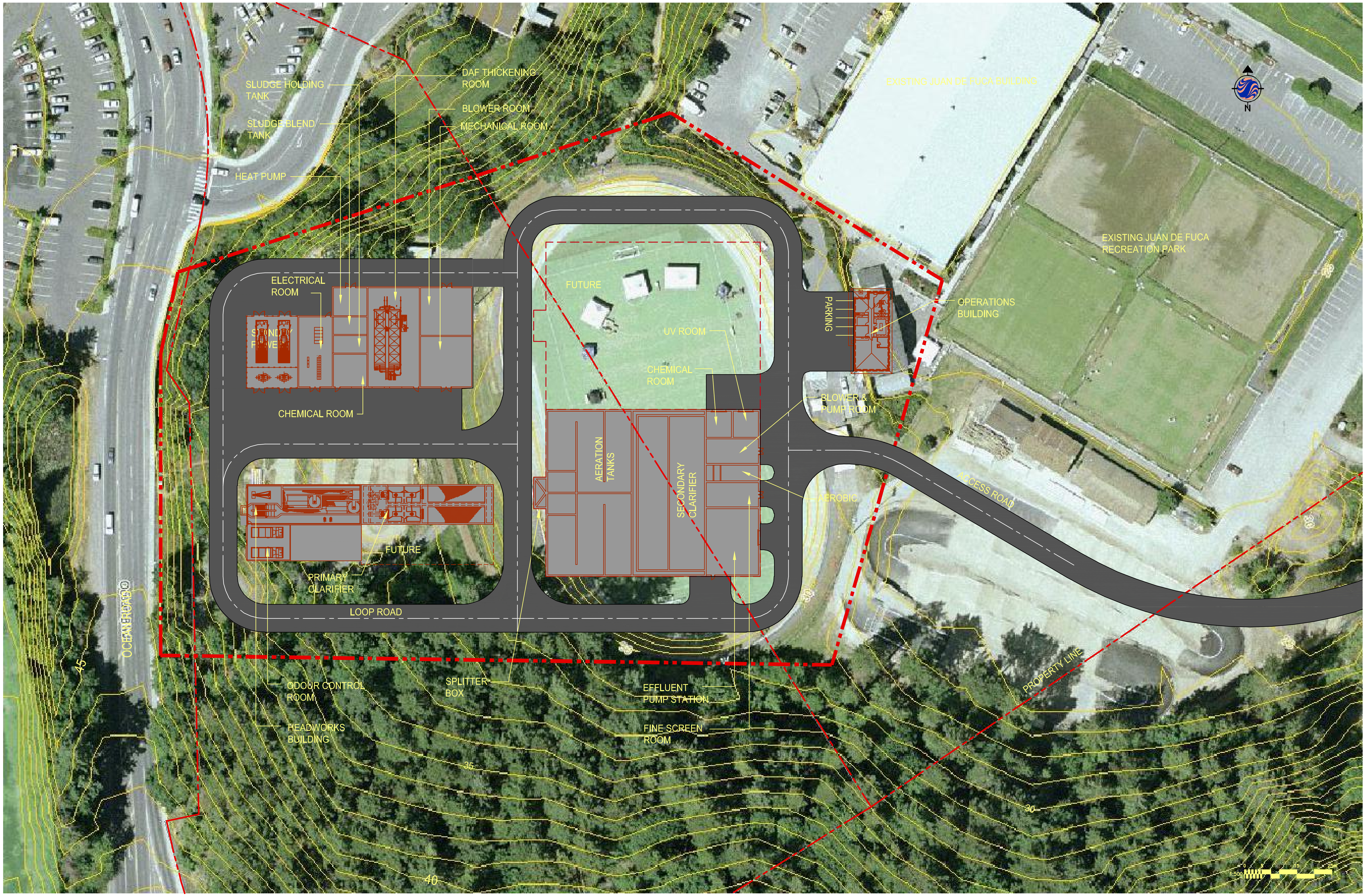
CORE AREA WASTEWATER TREATMENT PROGRAM

McLOUGHLIN SITE
OPTION 1A
UV BUILDING FOR SECONDARY EFFLUENT
GENERAL ARRANGEMENT – PLAN AND SECTION

CONTRACT NUMBER –
DRAWING NUMBER ML-A1-P-400
ISSUE –
SHT. No. – OF –



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CORE AREA WASTEWATER TREATMENT PROGRAM

WEST SHORE SITE
OPTION 1A
CONVENTIONAL ACTIVATED SLUDGE PROCESS
SITE PLAN

CONTRACT NUMBER	DRAWING NUMBER	ISSUE	SHT. No. OF
–	WS-A1-C-010	–	– OF –

West Shore Site - Wastewater Treatment Facility (Major equipment is designed for year 2030 flow with space for expansion)	
Design Parameters	Option 1A West Shore Wastewater Treatment Facility
Year 2030 ADWF (ML/d) Total	14
Year 2030 ADWF (ML/d) Tributary	14
Year 2065 ADWF (ML/d) Total	28
Year 2065 ADWF (ML/d) Tributary	28
Headworks: (Screens are sized for year 2065 flow)	
Mechanical Screen Hydraulic Capacity (ML/d)	112
No. of Screens with Compactors	2
Screen Size (mm)	6
Vortex Grit Removal Capacity (ML/d)	56
No. of Vortex Grit Chambers	2
Diameter of Vortex Grit Chamber	3500
No. of Grit Classifiers	1
High Rate Primary Clarifier with Lamella Plates and with CEPT Capability:	
Primary Treatment Capacity (ML/d)	56
No. of Primary Clarifier Trains	2
Type of Clarifier	Rectangular
Side Water Depth (m)	4.5
Surface Overflow Rate (m/h)	13
Lamella Plate Length (m)	3
Lamella Spacing (mm)	75
Lamella Plate Angle to Horizontal (Degree)	55
Lamella Plate Loading Rate (m/d)	32
Rapid Mix Detention Time (sec)	30
Rapid Mix G-Value (s^{-1})	5000
2-stage Flocculation Detention Time (min.)	10
Stage-1 Flocculation G-Value (s^{-1})	75 to 200
Stage-2 Flocculation G-Value (s^{-1})	25 to 100
Coagulant (Alum) Dosage (mg/L)	70 to 80
Coagulant Aid (Polymer) Dosage (mg/L)	1.5
Bioreactor:	
Design Hydraulic Capacity (ML/d)	28
No. of Process Trains	2
Target BOD Removal	95%
Organic Loading Rate F/M (kg of BOD/d/kg of MLSS)	0.3
Solids Retention Time (d)	3 to 5
Operating MLSS Concentration (mg/L)	1500 to 2500
Hydraulic Retention Time at Design Flow (h)	6
Water Depth (m)	6
Sludge Yield (kg of Cells/ kg of BOD removed)	0.8
Ratio of Pre-anoxic Selector to Bioreactor Volume	10%
Oxygen Requirement (kg of O_2/kg of BOD removed)	1.2
Oxygen Transfer Efficiency	28.00%
Return Activated Sludge Rate	0.25 to 0.5 of Q

Secondary Clarifier:	
Design Hydraulic Capacity (ML/d)	28
No. of Process Trains	2
Type of Clarifier	Rectangular
Side Water Depth (m)	4.5
Surface Overflow Rate (m/d)	24
Solids Loading Rate (kg/h/m^2)	5
Return Activated Sludge Pumping Rate	0.25 to 0.5 of Q
Tertiary Membrane Filtration for Water Reuse:	
Secondary Treatment Hydraulic Capacity (ML/d)	2
No. of Membrane Trains	1
Water Depth (m)	5.5
Membrane Tank Volume (m^3)	120
Design HRT (h)	3.5
Disinfection for Water Reuse:	
Design Flow for Water Reuse (ML/d)	2
No. of UV Reactors	2
Reactor Flange Size (mm)	300
Minimum UV Transmittance	70%
Maximum Total Suspended Solids (mg/L)	5
Design UV Dose (mJ/cm^2)	80
Disinfection Limit (Fecal Coliform MPN / 100 ml)	2.2
Sodium Hypochlorite Solution Concentration	12%
Disinfection for Secondary Effluent:	
Design Flow (ML/d)	28
No. of UV Channels	2
No. of UV Banks	4
Minimum UV Transmittance	60%
Maximum Total Suspended Solids (mg/L)	30
Design UV Dose (mJ/cm^2)	24000
Disinfection Limit (Fecal Coliform MPN / 100 ml)	200
Dissolved Air Flotation Thickener (DAF):	
Biosolids (kg/d)	5987
No. of Thickeners	1
Surface Loading Rate (kg/d/m^2) at 5d/week x 8h/d	48
Outfall:	
New Outfall Diameter (mm)	675
New Outfall Length (m)	3000

Xrefs: A1-CRD-TITLE.DWG; Drawing: V:\1490\149009002\DRAWINGS\OPTION 1A\WS-A1-G-010.DWG November 20, 2009 2:22 p.m.

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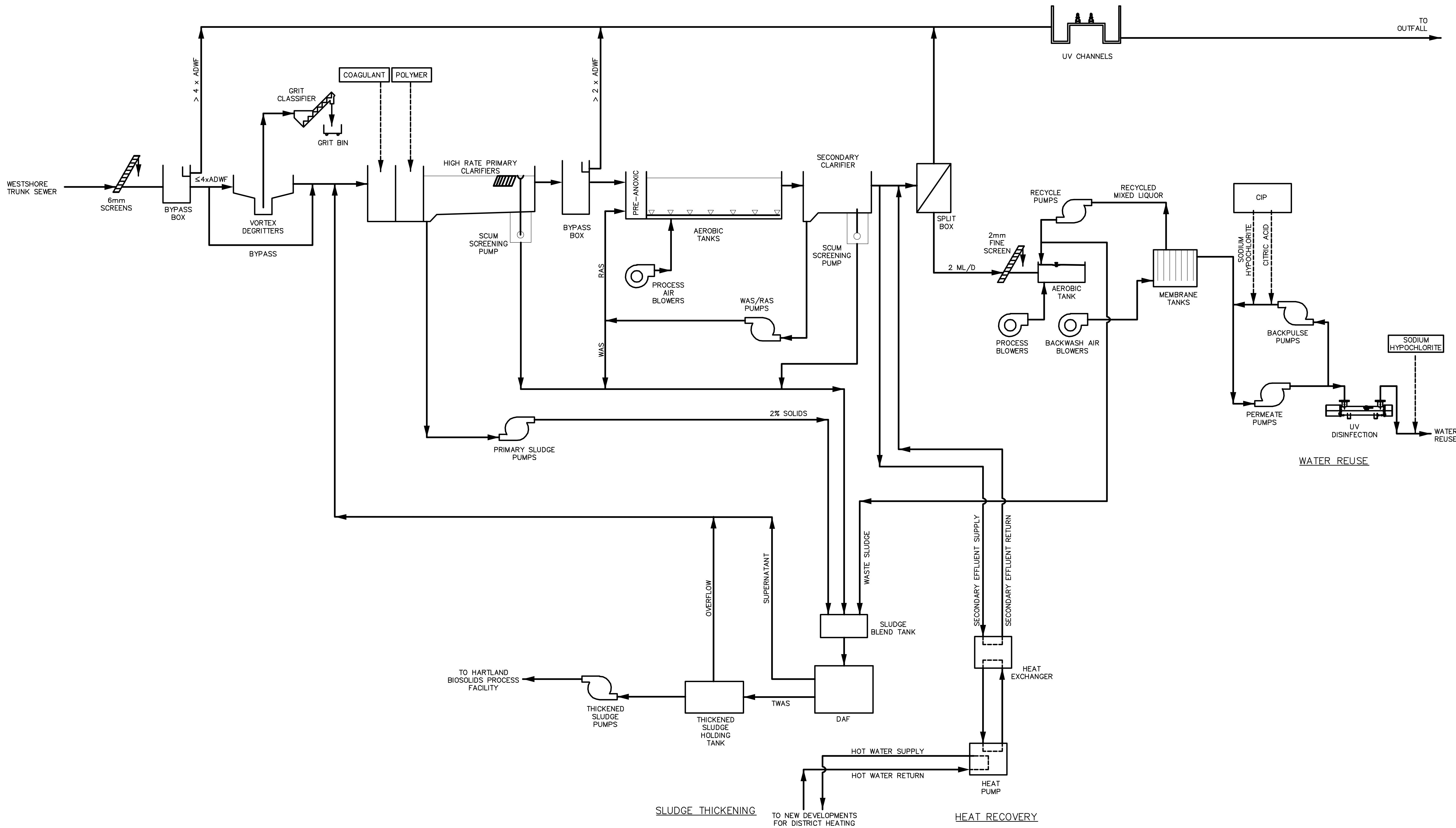
CORE AREA WASTEWATER TREATMENT PROGRAM

WEST SHORE SITE
OPTION 1A
DESIGN CRITERIA

CONTRACT NUMBER – | DRAWING NUMBER WS-A1-G-010 | ISSUE – | SHT. No. – OF –



Xrefs: xref_PFD.DWG; A1-CRD-TITLE.DWG;
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November 20, 2009 2:22 p.m.

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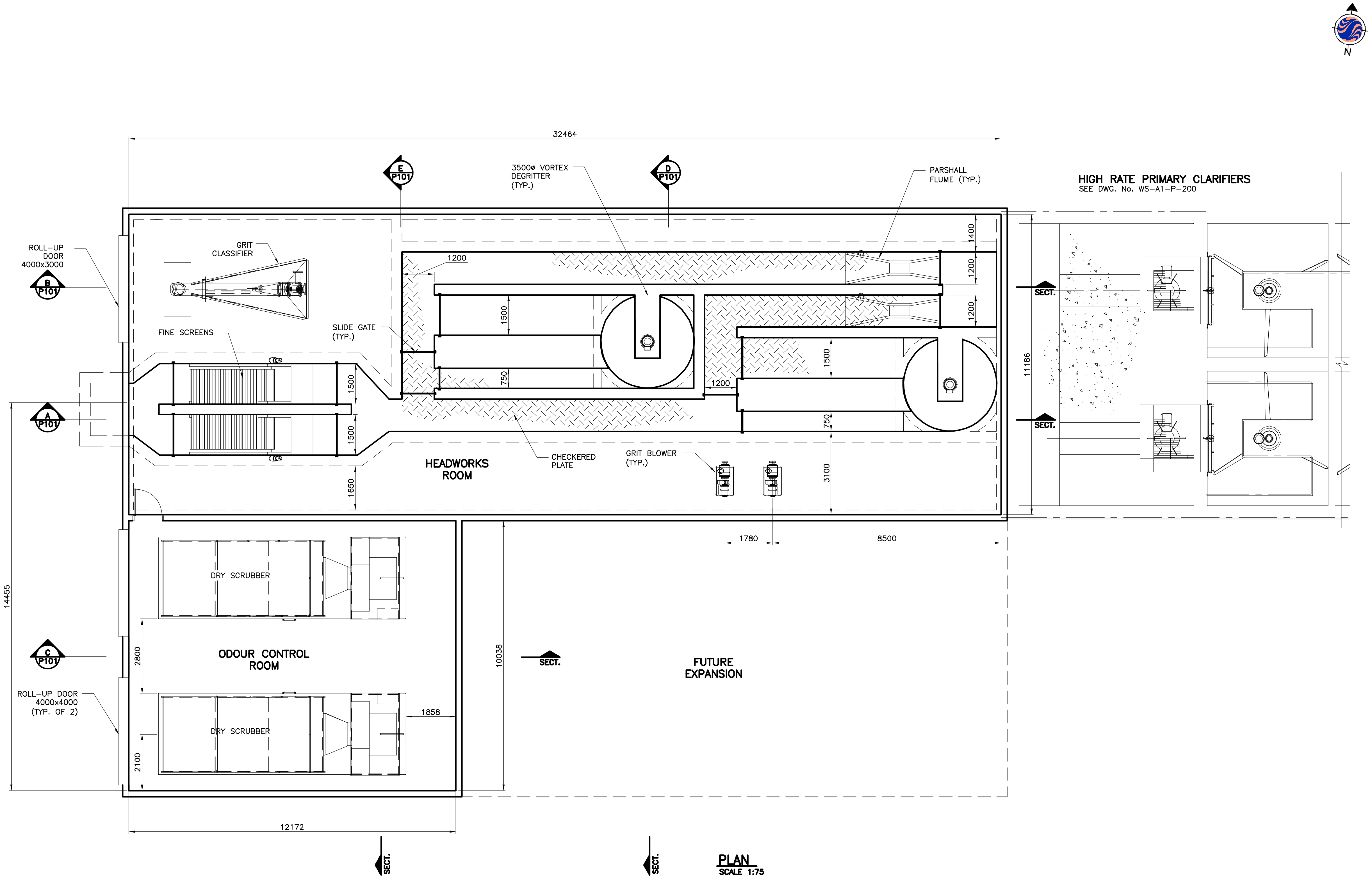
CORE AREA WASTEWATER TREATMENT PROGRAM
WEST SHORE SITE
OPTION 1A
PROCESS FLOW DIAGRAM

CONTRACT NUMBER – | DRAWING NUMBER WS-A1-G-015 | ISSUE – | SHT. No. – OF –



Xrefs: JF-A-HIGH RATE CLARIFIERS.DWG; JF-A1-HEADWORKS.DWG; A1-CRD-TITLE.DWG;
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November 20, 2009 3:20 p.m.

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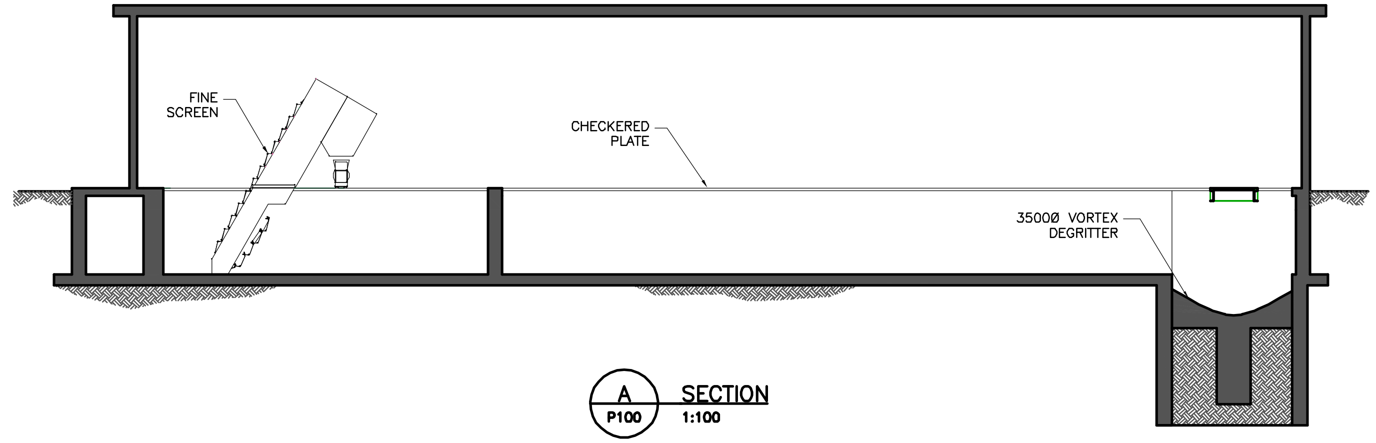
CORE AREA WASTEWATER TREATMENT PROGRAM

WEST SHORE SITE
OPTION 1A
HEADWORKS
GENERAL ARRANGEMENT – PLAN

CONTRACT NUMBER	DRAWING NUMBER	ISSUE	SHT. No.
–	WS-A1-P-100	–	– OF –



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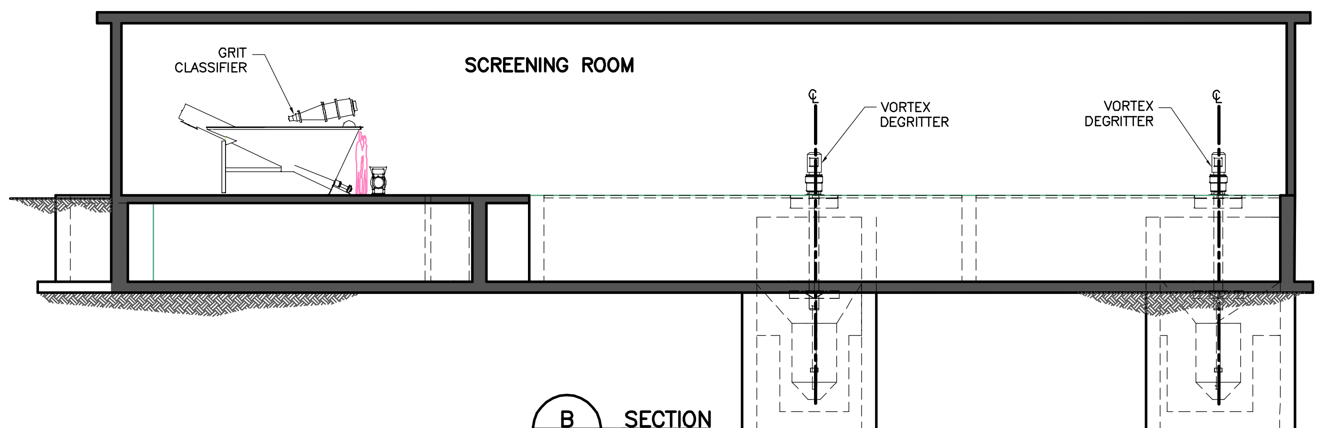

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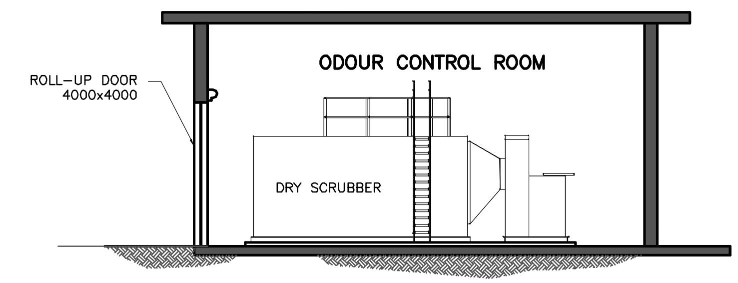

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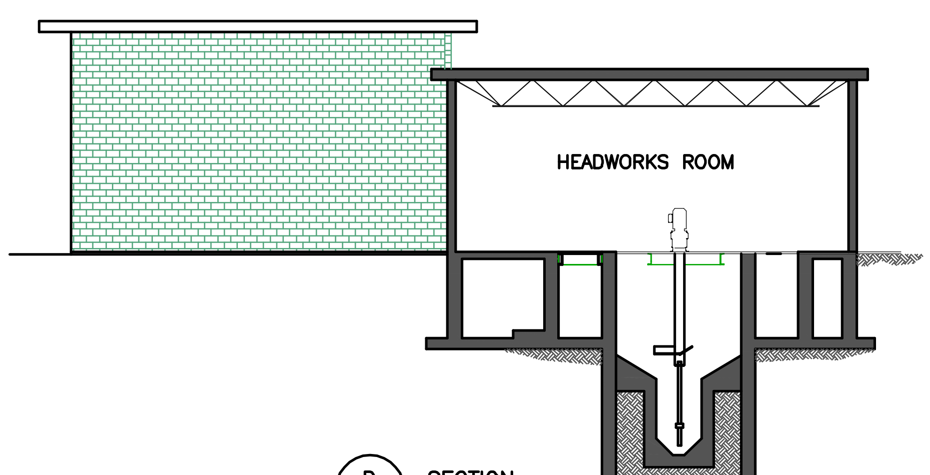

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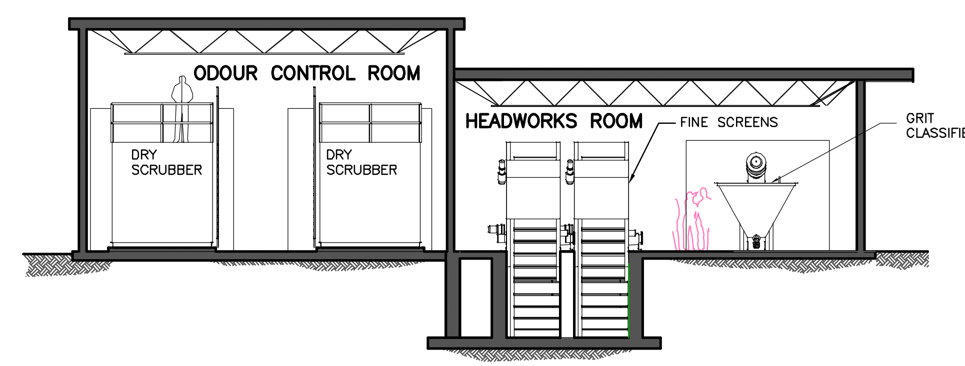

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November 20, 2009 3:20 p.m.

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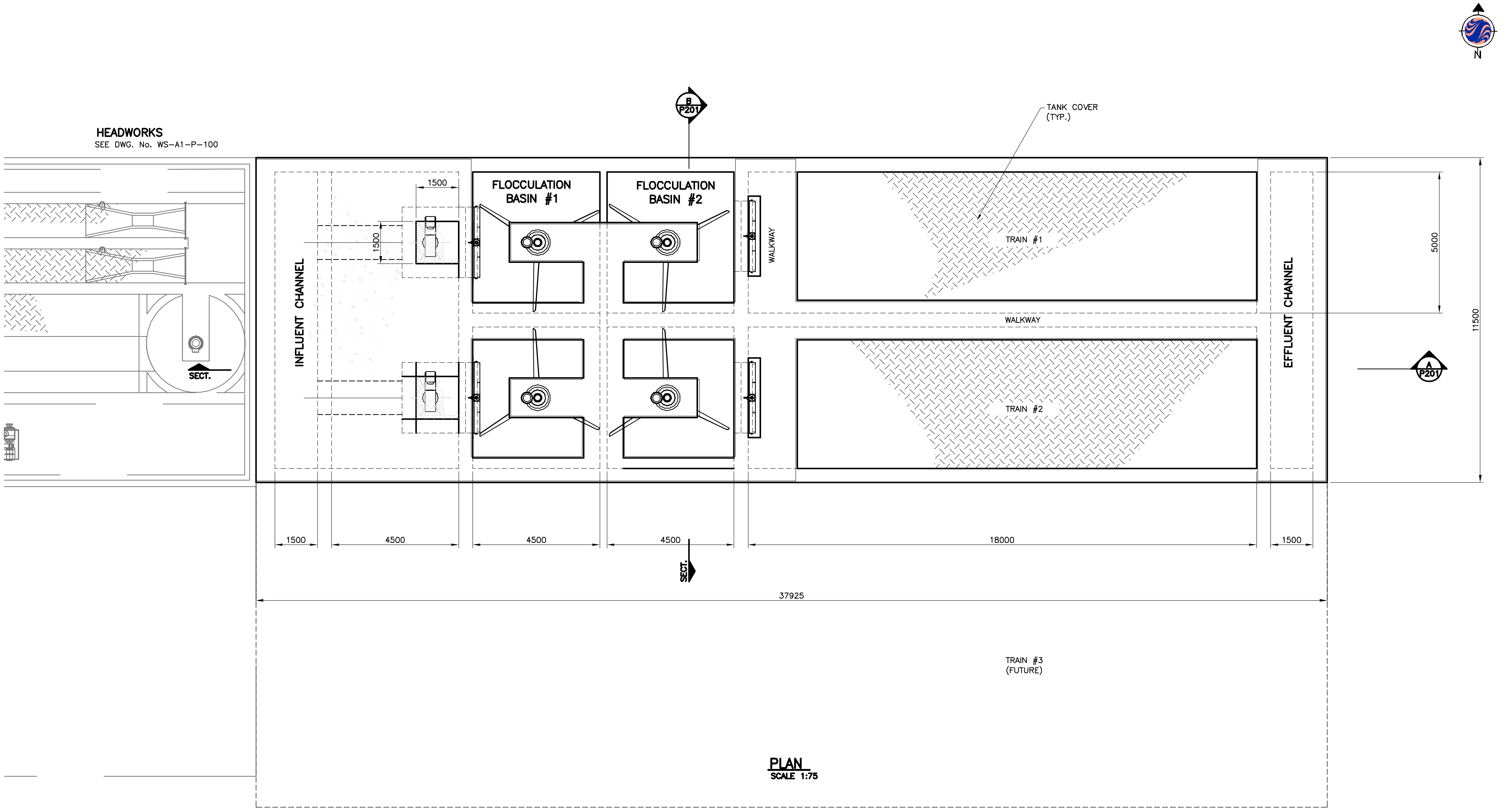
CORE AREA WASTEWATER TREATMENT PROGRAM

WEST SHORE SITE
OPTION 1A
SCREENING / GRIT REMOVAL FACILITY
SECTIONS

CONTRACT NUMBER – | DRAWING NUMBER WS-A1-P-101 | ISSUE – | SHT. No. – OF –



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CORE AREA WASTEWATER TREATMENT PROGRAM

WEST SHORE SITE
OPTION 1A
HIGH RATE PRIMARY CLARIFIERS (LAMELLA PLATE) WITH CEP
GENERAL ARRANGEMENT

CONTRACT NUMBER	DRAWING NUMBER	ISSUE	SHT. No. OF
–	WS-A1-P-200	–	– OF –

Xrefs: JF-A-HIGH RATE CLARIFIERS.DWG; JF-A1-HEADWORKS.DWG; A1-CRD-TITLE.DWG;
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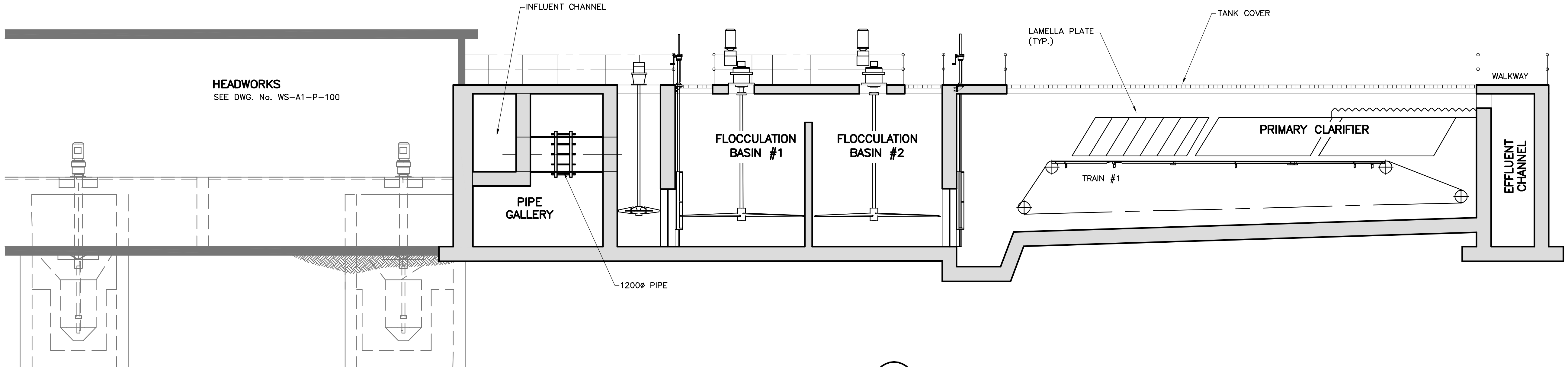

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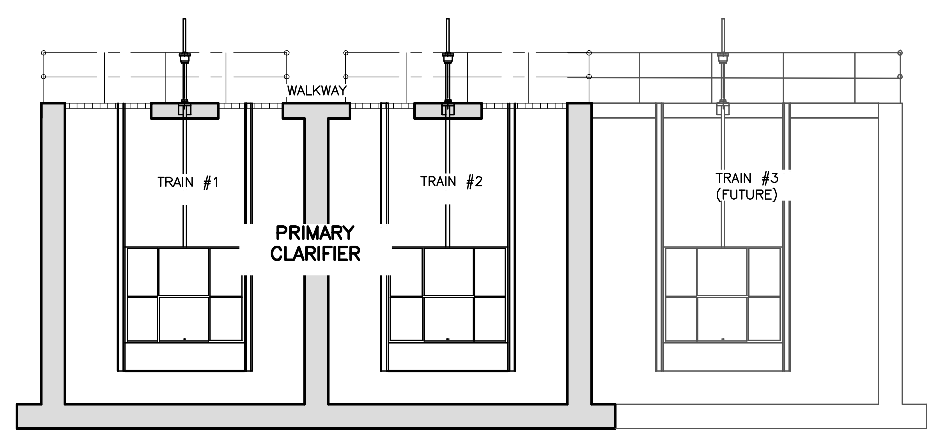

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November 20, 2009 9:28 a.m.

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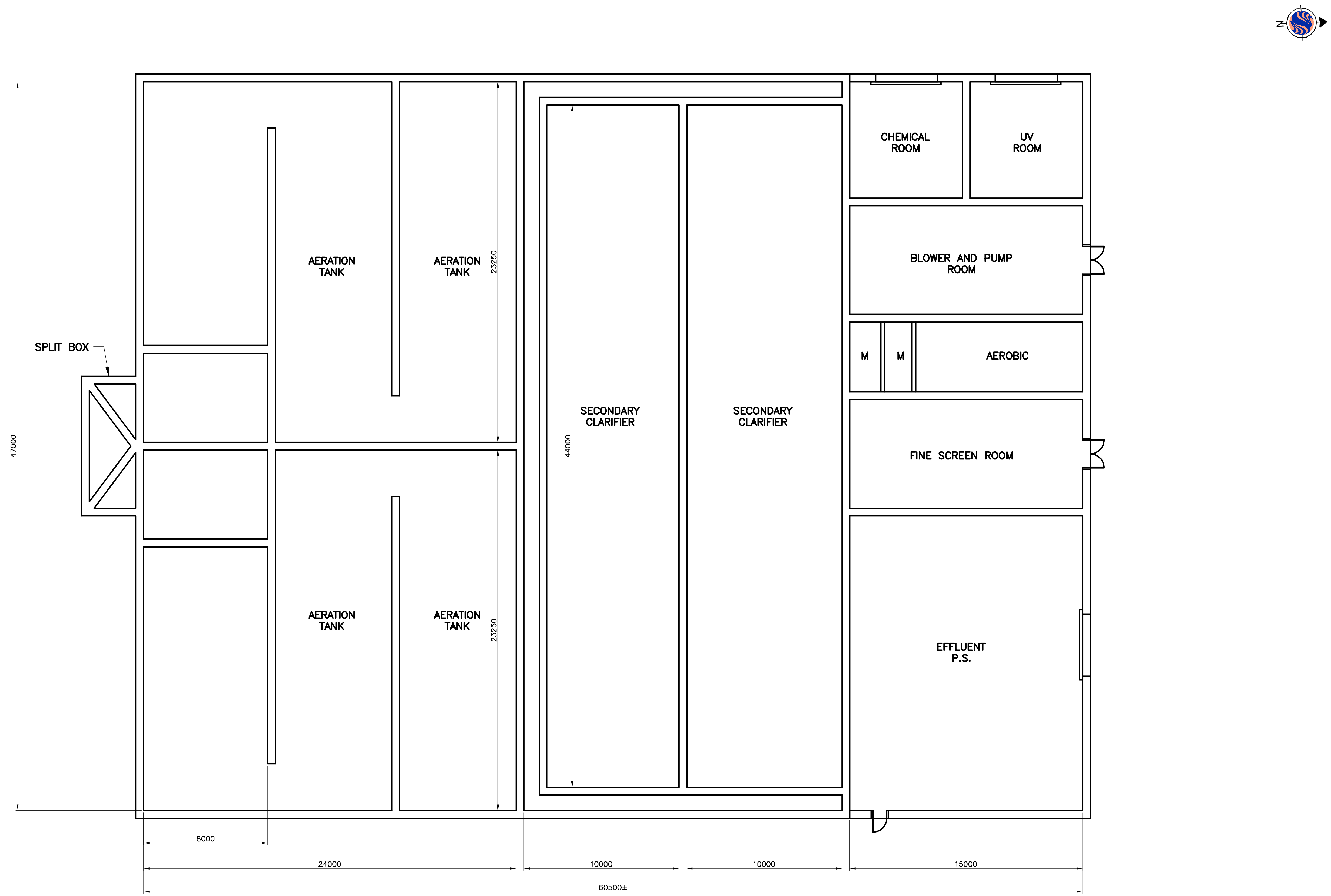
CORE AREA WASTEWATER TREATMENT PROGRAM

WEST SHORE SITE
OPTION 1A
HIGH RATE PRIMARY CLARIFIERS (LAMELLA PLATE) WITH CEP
GENERAL ARRANGEMENT – SECTIONS

CONTRACT NUMBER – | DRAWING NUMBER WS-A1-P-201 | ISSUE – | SHT. No. – OF –



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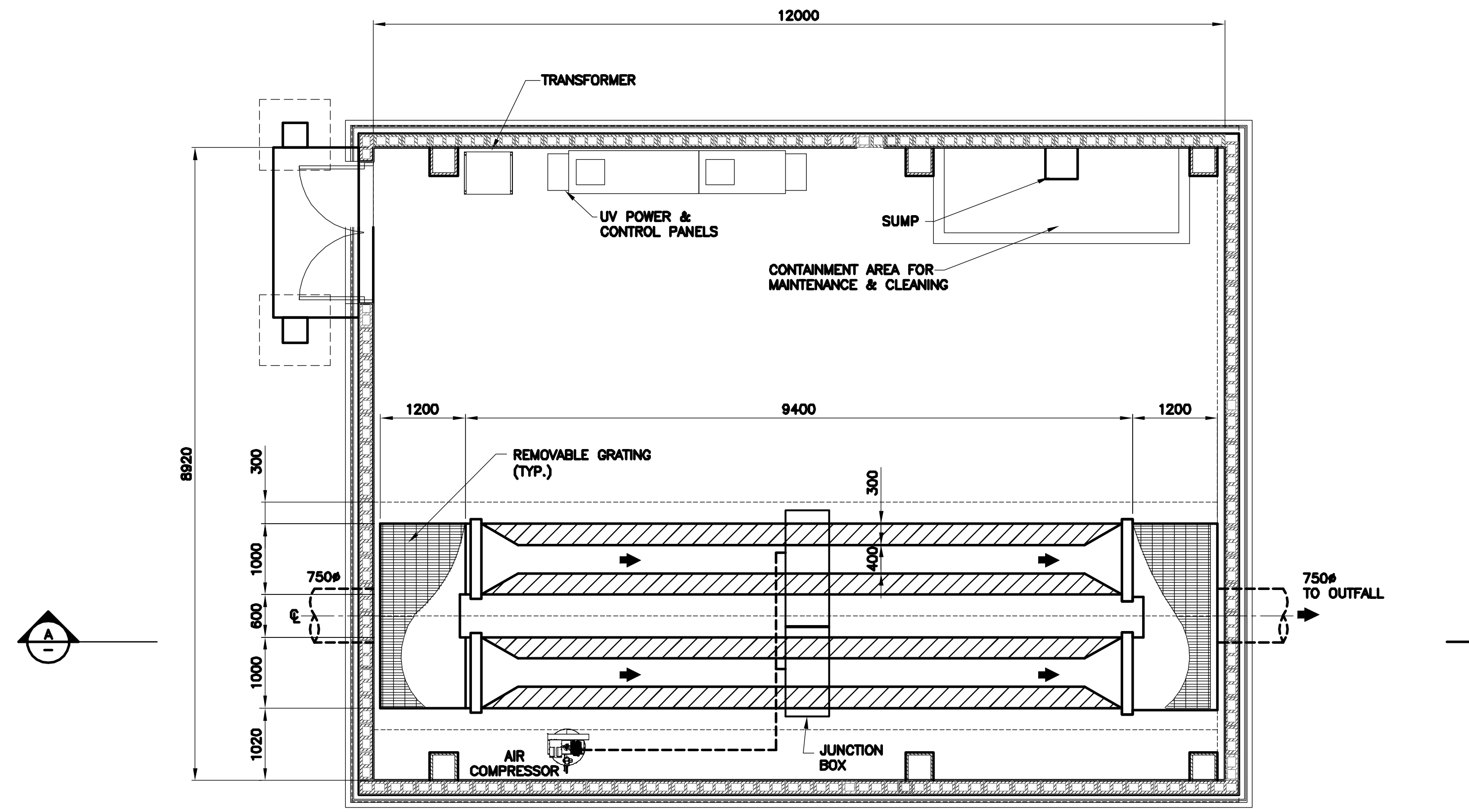
WEST SHORE SITE
OPTION 1A
CAS & SECONDARY CLARIFIERS
GENERAL ARRANGEMENT–PLAN

CONTRACT NUMBER – | DRAWING NUMBER WS-A1-P-300 | ISSUE – | SHT. No. – OF –



PLAN
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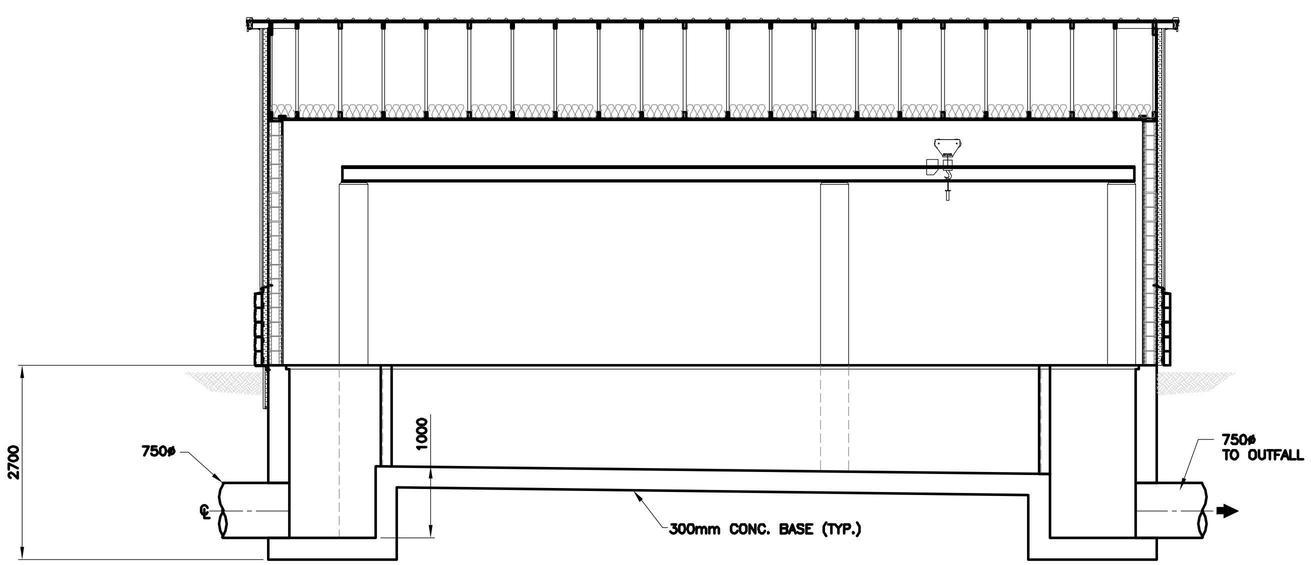

SECTION A
SCALE: 1:50

Xrefs: JF_UV BUILDING.DWG; A1-CRD-TITLE.DWG;
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November 20, 2009 9:30 a.m.

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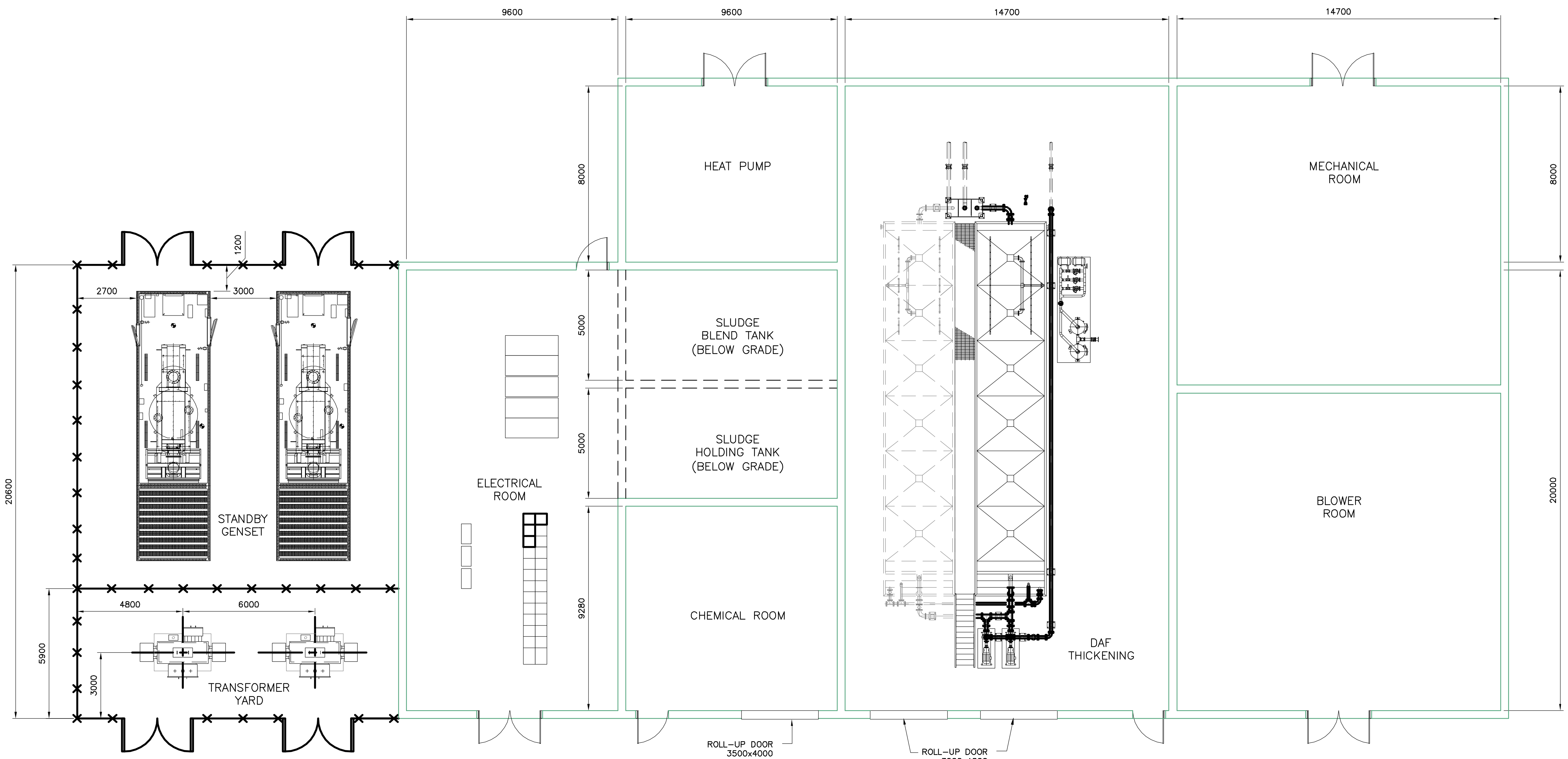
SCALE VERTICAL	–	APPROVED	RAF

CORE AREA WASTEWATER TREATMENT PROGRAM

WEST SHORE SITE
OPTION 1A
UV BUILDING FOR SECONDARY EFFLUENT
GENERAL ARRANGEMENT – PLAN AND SECTION

CONTRACT NUMBER –
DRAWING NUMBER WS-A1-P-400
ISSUE –
SHT. No. – OF –



PLAN
SCALE 1:100

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SCALE VERTICAL –	APPROVED RAF

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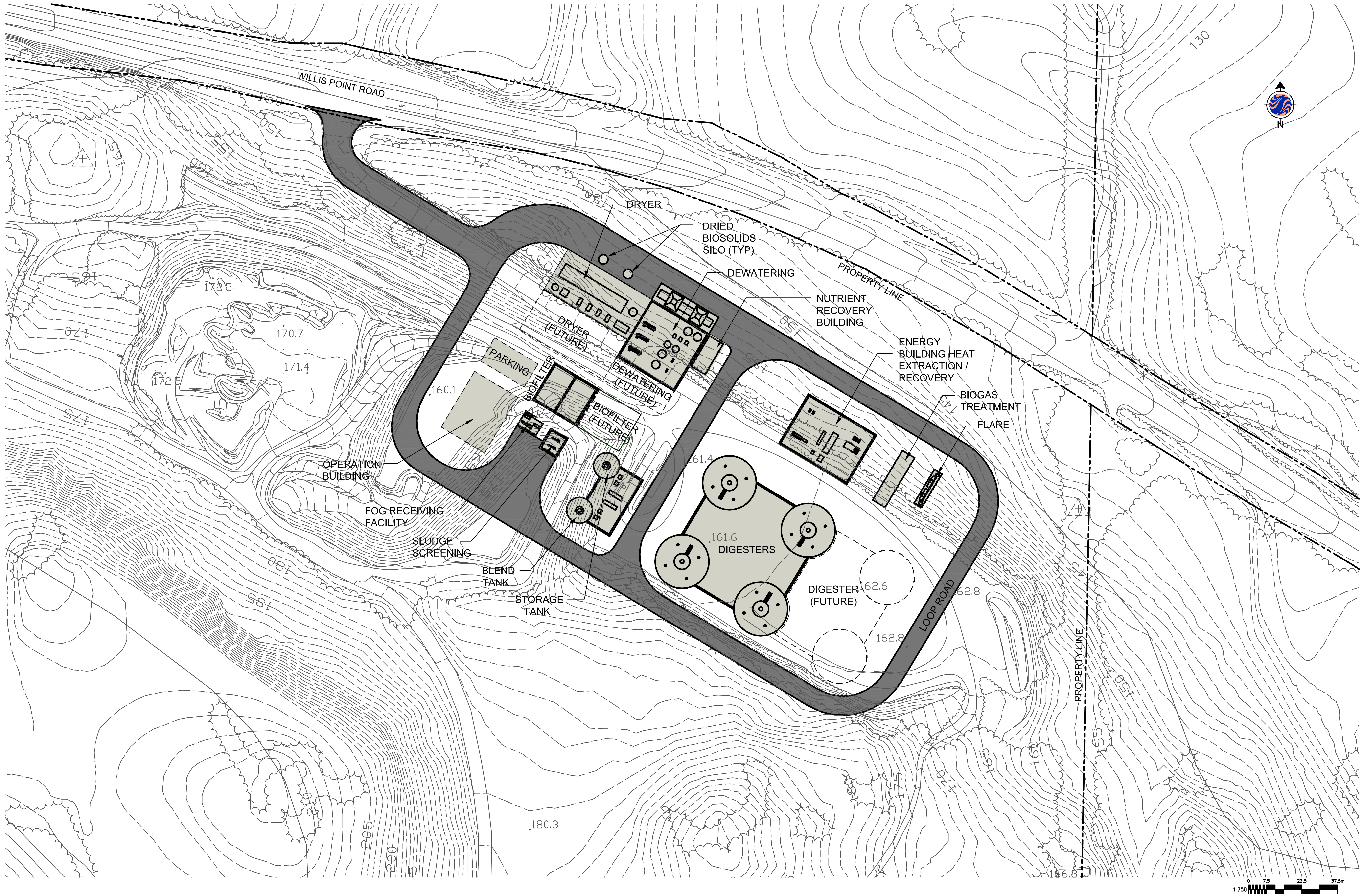
WEST SHORE SITE
OPTION 1A
SLUDGE THICKENING BUILDING
GENERAL ARRANGEMENT – PLAN

CONTRACT NUMBER	DRAWING NUMBER	ISSUE	SHT. No. OF
–	WS-A1-P-500	–	– OF –



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November 20, 2009 11:19 a.m.

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CORE AREA WASTEWATER TREATMENT PROGRAM

HARTLAND LANDFILL SITE
OPTION 1A
BIOSOLIDS TREATMENT FACILITIES
SITE PLAN

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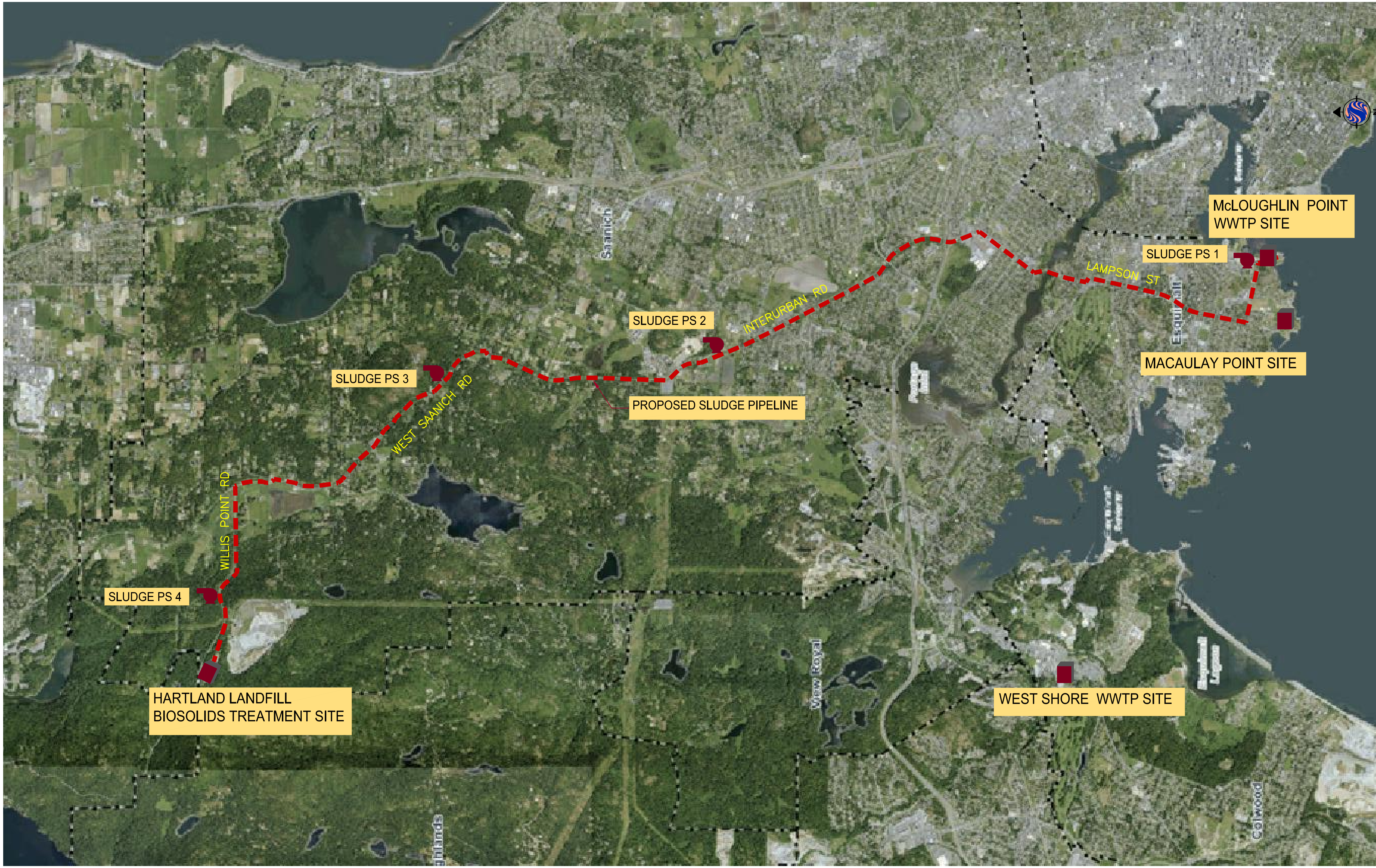
–	HL–A1–C–010	–	– OF –



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CORE AREA WASTEWATER TREATMENT PROGRAM

HARTLAND LANDFILL SITE
OPTION 1A
200ø SLUDGE PIPELINE
–

CONTRACT NUMBER – | DRAWING NUMBER HL–A1–C–011 | ISSUE – | SHT. No. – OF –