NEEGAN BURNSIDE

Whitesand First Nation Cogeneration and Pellet Mill Project

Surface Water Assessment Report

Sagatay Cogeneration LP

October 2014

Whitesand First Nation
Cogeneration and Pellet Mill Project

Surface Water Assessment Report

Prepared By:

Neegan Burnside Ltd.
292 Speedvale Avenue West Unit 20 Guelph ON N1H 1C4

Prepared for:

Sagatay Cogeneration LP, with its General Partner, Sagatay Cogeneration Ltd., and Whitesand First Nation as agent

October 2014

File No: 300030895.0000

Record of Revisions

Revision	Date	Description
0	December 18, 2013	Draft Report Submission for Consultation
1	October 17, 2014	Application to the Ministry of the Environment and Climate Change for Renewable Energy Approval

Executive Summary

Sagatay Cogeneration LP, with its General Partner, Sagatay Cogeneration Ltd., and Whitesand First Nation as agent is proposing to develop, construct and operate a biomass fueled electric power and heat cogeneration plant, and wood pellet facility. The Project is located on Crown Land in an unorganized territory of the Thunder Bay District near Whitesand First Nation and Armstrong Station, Ontario. The unorganized territory is administered by the Armstrong Local Service Board and the Project will be located solely on the traditional territory of Whitesand First Nation. An Application for Renewable Energy Approval is being prepared under O.Reg. 359/09 of the *Environmental Protection Act*. The cogeneration plant and ancillary equipment is classified as a Class 1 Thermal Facility under O.Reg. 359/09.

Based on a review of existing information, agency records and a Site investigation as part of the Water Assessment for the Project, five water bodies were found to be present within 300 m of the Project Location; none of which are located at or within 120 m of the Project Location. As such, these water bodies are considered in this Surface Water Assessment Report, but a more detailed description of the water bodies are provided in the Water Assessment Report under a separate cover.

All proposed construction and decommissioning activities will be in accordance with the “Measures to Avoid Causing Harm to Fish and Fish Habitat” published by Fisheries and Oceans Canada. These measures, combined with an erosion and sediment control plan as outlined in this report, will ensure protection of surface water quality, fish, and fish habitat during construction and decommissioning. Stormwater management during Project operation is proposed to be addressed by a bio-swale as outlined in this report. A monitoring program and contingency measures are also described to detect and respond to potential impacts on water bodies in the vicinity of the Project.

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Appendices

1.0 Introduction

1.1 Project Overview

Sagatay Cogeneration LP, with its General Partner, Sagatay Cogeneration Ltd., and Whitesand First Nation (Whitesand) as agent is proposing to develop, construct and operate a biomass fueled electric power and heat cogeneration plant, and wood pellet facility (the Project). The Project is located on Crown Land in an unorganized territory of the Thunder Bay District near Whitesand First Nation and Armstrong Station, Ontario. The unorganized territory is administered by the Armstrong Local Service Board and the Project will be located solely on the traditional territory of Whitesand First Nation.

The general Project components include a biomass fueled electric power and heat cogeneration plant, wood pellet plant, maintenance garage, material storage and handling areas, wastewater management system, water storage pond, wells, pump building, and transformer substation. The only biomass used to fuel the cogeneration plant will be woodwaste, making it a Class 1 Thermal Facility under Ontario Regulation 359/09 (O.Reg. 359/09) of the Environmental Protection Act. The proposed Class 1 Thermal Facility would have a nameplate capacity of up to 3.6 MW, and would displace the energy supply from existing diesel generators servicing the community via a local grid, operated by Hydro One Remote Communities Inc., as well as supply electricity for the Project. The local grid is not connected to the Provincial grid, and there are no such future plans for a transmission connection. The Project Location is presented in Figure A1 of Appendix A.

This Surface Water Assessment Report has been prepared in support of an Application for Renewable Energy Approval under O.Reg. 359/09 for the Project.

1.2 Report Requirements

This Surface Water Assessment Report is required to satisfy the requirements listed in Table 1, as defined by O.Reg. 359/09. This report was also prepared according to guidance from the Technical Guide to Renewable Energy Approvals (MOE, 2013). The organization of this report is structured according to the two general requirements of Table 1 as follows:

- Plans, Specifications, and Descriptions of Surface Water Features; and,
- Assessment of Facility Suitability.

Table 1 Report Requirements

Item	Requirement Met	Reference in this Report
1. Report to be completed by one of the following persons after the person has carried out a surface water assessment in respect of the renewable energy project:		
i. A professional engineer.	N/A	N/A
ii. A professional geoscientist.	N/A	N/A
iii. A person working under the supervision of a person mentioned in subparagraph i or ii.	Yes	Undersigned
2. Set out the following information:		
i. Plans, specifications and descriptions of the surface water features at the project and any surface water features that will receive a direct discharge of sewage as part of engaging in the project.	N/A	N/A
ii. An assessment of the suitability of the facility for the handling, storage and processing of biomass, source separated organics or farm material, taking into account:		
a. The design of the facility, including features that will be implemented to control the expected production of leachate, the flow of surface water and erosion and sedimentation resulting from the flow of surface water;	Yes	Section 3.1
b. The surface water features within 300 m of the location where biomass, source separated organics or farm material will be handled, stored or processed, any surface water features that will receive a direct discharge of sewage from the facility and the surface water features of the Project Location;	Yes	Section 3.2
c. The ability to identify any negative environmental effects of leachate production on the surface water by monitoring; and	Yes	Section 3.3
d. The feasibility of contingency plans that can be implemented to control the negative environmental effects on surface water resulting from the production of leachate in a quantity greater than expected or with a quality worse than expected.	Yes	Section 3.4

1.3 Project Location

The Project is located on Crown Land in an unorganized territory of the Thunder Bay District near Whitesand First Nation and Armstrong Station, Ontario; approximately 210 km north of Thunder Bay, and 2 km south of Armstrong Station. The Project will be located on the traditional territory of Whitesand First Nation. This Project context is shown in the key map of Figure A1 of Appendix A.

The “Project Location” is defined in O.Reg. 359/09 as:

“a part of land and all or part of any building or structure in, on or over which a person is engaging in or proposes to engage in the project and any air space in which a person is engaging in or proposes to engage in the project”.

The Project Location also includes any temporary work areas required to construct the Project. The cogeneration plant, pellet plant, maintenance garage, wastewater management system, water storage pond, and associated equipment and temporary work areas will be contained within a boundary of approximately 35 ha as shown on Figure A1 of Appendix A. For reference, a Site Plan of the Project is shown within the Project Location in Figure A1 of Appendix A.

There is an existing electricity distribution connection owned and operated by Hydro One Remote Communities Inc. that will be used to connect the Project to the local grid. It is within an existing right-of-way extending from the Site to the nearby existing diesel generating station. Any upgrades required to the existing electricity distribution connection will be the responsibility of Hydro One Remote Communities Inc.

Solid waste generated at the facility will be disposed of off-site at an approved disposal facility.

1.3.1 Site Description

The approximately 35 ha Site was originally developed circa 1989 to be used for a garage, fuel storage facility, office, trailer camp and possibly a wood storage facility. However, the facility was abandoned and is currently not in use.

2.0 Plans, Specifications, and Description of Surface Water Features

According to O.Reg. 359/09, surface water features at the Project Location and any surface water features that will receive a direct discharge of sewage as part of engaging in the Project must be described in the Surface Water Assessment Report.

As previously mentioned, the Site is comprised of 35 ha of Crown Land, some of which was previously used as an industrial forestry camp. The footprint of this camp remains obvious and is largely cleared. The remaining portions of the Site property are forested, varying in stages of growth.

Throughout the records review and Site Investigation portions of the Water Assessment for the Project, no surface water features were observed at or within 120 m of the Project Location. However, five surface water bodies were encountered within the 300 m of the Project Location.

Since no surface water features were encountered at the Project Location, no plans, specifications, or descriptions of them will be addressed in this report. Also, as the proposed facility will be equipped with a subsurface wastewater management and disposal system, no surface water feature will receive a direct discharge of sewage as part of engaging in the Project. For a description of the surface water features within 300 m of the Project Location, refer to the Water Assessment Report under a separate cover.

Stormwater runoff from this Site will be both infiltrated and directed via vegetated overland routes, eventually to existing bodies of water. Mitigation measures have been proposed to ensure minimal impacts on receiving bodies of water.

3.0 Assessment of Facility Suitability

This section of the report presents the assessment of the suitability of the facility for the handling, storage and processing of biomass, taking into account:

- Facility Design;
- Surface Water Features within 300 m of Biomass Locations;
- Environmental Effects of Leachate Production; and,
- Contingency Plan Feasibility.

3.1 Facility Design

The Project includes a variety of components with the overall objective to generate electricity and create premium grade wood pellets. A general description of each component of the Project is described below. Conceptual diagrams of the various processes at the facility, including the required equipment for each process, are provided in Appendix B.

3.1.1 Woodyard

The Project components relating to the woodyard can generally be characterized as the ancillary features that will be used to facilitate material transport, processing, conditioning, storage, and equipment operation and maintenance. The wood pellet shipping area, truck scale approach and exit ramps, and biomass storage pads will be hard surfaced (i.e., asphalt or concrete) to facilitate material handling and storage. The remaining portions of the yard will consist of gravel access roads, or will remain as existing gravel or vegetation. The site will be equipped with the appropriate fire, safety, security, communications equipment and underground utilities. Detailed diagrams of the processes and equipment in the yard are provided in Appendix B, and the Site Plan is shown in Figure A1 of Appendix A.

The general components at the wood processing yard include:

- Gravel access roads;
- Hard surfaced areas for biomass storage and pellet shipping;
- A truck scale and truck dumpers;
- A mechanical conveyor system with ancillary equipment;
- A biomass belt dryer;
- A maintenance garage;
- Waste oil and propane storage;
- A diesel fuel storage and filling system;
- Underground utilities; and,
- Fire, safety, security, and communications equipment.

Significant portions of the site have been left largely untouched, which will promote on-site infiltration and minimize runoff volumes. Furthermore, the hard-surfaced areas where biomass is being stored will limit biomass mixing with soils and associated direct absorption of leachate. It is assumed that all site drainage will be directed to the south/southeast boundary of the Project Location.

Specified equipment along the mechanical conveyor system, Motor Control Centers (MCCs), and maintenance garage will be sheltered, such that stormwater will not mix with their respective equipment or processes. In addition, the maintenance garage will be designed such that wash-up water will be diverted to a floor drain, through an oil/grit separator, and into the subsurface wastewater management system. Other waste oil from site operations will be stored in metal barrels in a sheltered enclosure with a containment sump for storage until there is adequate material to warrant a pick-up for disposal off-site at an approved facility. All site oil/grit separators will also be regularly inspected and serviced for off-site disposal, as required.

The diesel fuel storage and filling station will include above ground tanks on a hard surface, and will comply with the requirements of O.Reg. 217/01, *Liquid Fuels*, and the Ontario Liquid Fuels Handling Code. Propane bottle storage will be located on the hard surfaced area adjacent to the pellet plant and will be covered and secured.

For all Project buildings, any hazardous material will be stored in appropriate, labeled containers, with Material Safety Data Sheets in each building where the hazardous material will be used or stored. There will be appropriate spill control kits on-site, and a spill response plan in place in which all employees will be trained.

3.1.2 Biomass Cogeneration Plant and Pellet Plant

The biomass cogeneration plant and pellet plant will be enclosed in covered buildings such that stormwater will not mix with their respective equipment or processes. Stormwater runoff from the plant roofs will flow overland, away from the plants. Where gutters and downspouts are required, they will include splash pads to diffuse flows and reduce erosion.

The equipment and processes inside the biomass cogeneration plant and pellet plant will not affect surface water features as all process and domestic wastewater will be collected and treated by a subsurface wastewater management system. Furthermore, an oil/grit separator will be installed to collect maintenance garage wash-up water prior to disposal in the subsurface wastewater management system. As noted above, oil/grit separators will be regularly inspected and serviced for off-site disposal, as required.

3.1.3 Water Supply and Storage

Facility process water and potable domestic water is expected to be supplied via existing on-site wells and an underground water distribution system. Water supply for firefighting is expected to be supplied via an on-site storage pond with a footprint of approximately 3,650 m^2 (39,288 ft^2). A covered pump building would be required adjacent to the pond and would have a footprint of approximately 150 m^2 (1,615 ft^2). If feasible, water supply for firefighting may alternatively be supplied via storage tanks within the heated portions of on-site buildings.

The water supply and storage features of the Project are expected to have a negligible impact on surface water features. Since the pond is designated exclusively for fire protection water supply, the Site will not be graded to direct stormwater into it. The pond will have a berm, and a designed overland flow spillway to direct excess stormwater falling directly on the pond overland to the south/southeast, along with the rest of the site drainage.

3.1.4 Wastewater Management

As noted above, a subsurface wastewater management system has been designed to treat and dispose of process and domestic wastewater underground via a leaching bed. As noted above, the oil/grit separators on-site will be regularly inspected and serviced for off-site disposal, as required. The wastewater management system will also be inspected regularly, and will include monitoring controls and alarms as required. Further details regarding the wastewater management system are detailed in the Effluent Management Plan Report, under a separate cover.

3.1.5 Transformer Substation

A main transformer substation will be constructed near the entrance of the Site to step up the voltage of the electricity produced by the cogeneration plant from 5 kV to 25 kV. This is required to match the voltage of the electricity distribution line operated by Hydro One Remote Communities. The transformer substation will have a granular surface, which will promote infiltration and reduce surface runoff. The main transformer will be equipped with a secondary containment system to contain transformer oil in the event of a failure. The transformer substation and secondary containment system will be inspected regularly, and oil will be removed from the secondary containment system as required.

In addition to the main transformer substation, there will also be three outdoor pad-mounted transformers servicing the cogeneration and pellet plants. These transformers will step down the voltage used by the buildings from 5 kV to 600 V for distribution to the plant loads. These pad-mounted transformers will be installed according to CAN/CSA-

C227.4-06 and/or the requirements of the authorities having jurisdiction. All oil-filled transformers will be installed over containment catchbasins.

3.1.6 Erosion and Sediment Control

In addition to the facility design features described above, erosion and sediment control will be further addressed during construction, operation, and decommissioning as outlined in Section 4.0.

3.2 Surface Water Features within 300 m of Biomass Locations

As noted in Section 2.0, five small ponds are located within 300 m of the Project Location, none of which are at or within 120 m of the Project Location. The majority of the Project features are located towards the northwest corner of the Project Location, away from the ponds. As it relates to biomass storage, handling and processing, the ponds are at least:

- 295 m away from the chipped/hogged biomass storage piles; and,
- 290 m away from the mechanical conveyor system and ancillary equipment.

It should be noted that biomass delivery trucks will temporarily use portions of the Site access roads that are within 190 m of the closest pond, and will be loaded and/or covered as required to prevent loss of biomass during transport. All other site features relating to biomass storage, handling and processing are more than 300 m away from the ponds in the vicinity of the Project. Furthermore, there will be a best management plan in place during operation to control particulate emissions from unpaved roads and biomass storage piles.

As outlined in the facility design above (Section 3.1), no surface water will receive a direct discharge of sewage from the Project. Chipped/hogged biomass will be stored on hard-surfaced (i.e., asphalt/concrete) areas, which will limit biomass mixing with soils and associated absorption of leachate.

3.3 Environmental Effects of Leachate Production

The proposed Project is within the Lake Nipigon watershed, where any Site runoff that does not naturally infiltrate/evaporate will eventually be received. A forested area off the property will remain between the Project Location and the existing ponds, which will facilitate further infiltration and quality control before the runoff reaches any surface water. As noted above, no significant leachate production that would negatively impact the existing surface water features is expected from the biomass. Furthermore, the subsurface wastewater management system has been designed according to the effluent limits in consultation with the Ministry of the Environment and Climate Change

(MOECC), as described in the Effluent Management Plan Report under a separate cover.

In order to confirm that surface water features are not negatively impacted by the Project, Ponds 1, 4, and 5 identified in the Water Assessment Report will initially be tested twice a year (during Spring after snow melt, and Summer) for three years. Testing will include chemical analysis to determine pollutant levels in each pond. The first round of testing will occur prior to construction to establish background conditions. These background conditions will be evaluated to set performance objectives in consultation with MOECC.

Subsequent testing will occur upon completion of Construction. If testing remains within the performance objectives for three years of Project operation; testing will discontinue. Otherwise, MOECC will be consulted to implement further mitigation, contingency, and testing procedures.

3.4 Contingency Plan Feasibility

If the bio-swale described in Section 4.0 fails or surface water testing reveals results outside the performance objectives, contingency measures will be implemented to achieve design objectives. Contingency measures may include:

- Minor Site re-grading to evenly distribute stormwater runoff;
- Planting smaller, denser vegetation (such as shrubs, bushes, and grass) at the downstream side of the Site to improve infiltration; and/or
- Improved shelter for biomass storage piles.

Wherever possible, restoration measures will be implemented to return the feature to its natural state. Restoration measures will vary depending on the nature of the impact and will be implemented in consultation with MOECC.

4.0 Stormwater Management Plan

Potential negative environmental impacts were taken into consideration when designing the stormwater management features for the proposed Site. The following list summarizes the principle stormwater design objectives:

- Mitigate adverse impacts on the surrounding environment and surface water bodies;
- Address operations and maintenance impacts; and
- Develop an erosion and sediment control plan for implementation during construction and decommissioning.

4.1 Drainage Design

Stormwater runoff will flow across the Site in the form of sheet flow toward the south end of the Site. The existing Site is partially developed and only small portions of the proposed development will be hard surfaces, so the increase in runoff has been calculated to be negligible. Calculations can be found in Appendix C.

The facility design features and spill response plan described in Section 3.1 provide mitigation for chemicals that may otherwise be conveyed by stormwater runoff. However, the runoff may collect silt and deposit sediment as it flows across the Site. This sedimentation will comprise the primary target of the on-site quality treatment.

4.2 Stormwater Treatment and Flow Mitigation

On the southwest end of the Site, the topography drops off significantly towards a small pond, yielding inopportune conditions for a vegetated filter strip. Instead, a permeable bio-swale will be installed to promote infiltration and filtration before runoff flows off-site. A level spreader at the end of the bio-swale will disperse flows prior to discharge to maintain slope stability and promote filtration through the vegetated area between the Site and the pond. This forested area provides approximately 120 m of off-site overland flow before the runoff reaches a surface water feature.

As shown in Table 2, the runoff coefficient does not increase from pre-development to post-development conditions, so the runoff quantities will not change significantly. The portions of the Site that are not required to house Project components will remain vegetated to aid in the runoff filtration process.

Table 2 Pre and Post Development Runoff Calculations

Site Condition	Runoff Coefficient
Pre-Development	0.31
Post-Development	0.31
Drainage Area to Bio-Swale	0.36

Runoff will be collected in a bio-swale running along the south edge of the property and filtered to minimize suspended solids in the Site's effluent. The bio-swale's required capacity was calculated using the Rational Method and rainfall intensity values from Armstrong Station IDF Curves obtained from the Ministry of Transportation http://www.mto.gov.on.ca/IDF_Curves/results_out.shtml?coords=50.299341,-89.039795 and are summarized in the table below:

Table 3 Runoff Summary

Design Storm	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
Runoff to Bio-Swale (L/s)	277	382	451	537	604	667

The bio-swale and subsequent level spreader have been designed to convey 100-year design storms. However, treatment provided by the bio-swale will be rendered ineffective for elevated flows like those during the 100-year storm. Treatment will remain most effective for smaller storm events. Flows will be dissipated over the level spreader at the end of the bio-swale. In addition to mitigating erosion on the slope directly south of the discharge point, this will decrease flow velocity in the bio-swale. Discharged flow will continue south down the slope and into a small pond located approximately 120 m south of the property line.

Geological and hydrogeological conditions at the Project Location were analyzed in the Design and Operations Report under a separate cover. Test pits were dug on and around the Site to determine the local soil composition. The majority of the soil is gravel and sand, with underlying bedrock, which will facilitate significant infiltration. The findings in that report helped determine the runoff's ability to infiltrate. A large percentage of the filtered water will be infiltrated back into the groundwater system due to the local soil's high porosity.

The groundwater table resides approximately 6.4 to 19.8 m below the ground surface. This is a significant depth, which also increases the Site's infiltration potential.

4.2.1 Operations and Maintenance

Maintenance is an important part of a drainage system. The bio-swale may require additional vegetation to improve its effectiveness. If scouring or erosion is observed in the swale, addition vegetation should be planted to ensure the bio-swale is operating properly.

The level spreader and bio-swale should be inspected once per year to ensure no damage has occurred to the structure or the vegetation.

Initial hydroseeding of the bio-swale must occur during the growing season to ensure the success and stability of the bio-swale long term.

4.3 Erosion and Sediment Control Plan

The construction and decommissioning Contractors shall design and implement an erosion and sediment control plan prior to all other works. The plan shall be in accordance with the “Measures to Avoid Causing Harm to Fish and Fish Habitat” published by Fisheries and Oceans Canada, and shall ensure that no deleterious substance enters a water body. The erosion and sediment control plan may include:

- Silt fence around the downstream area of the Project Location;
- A mud mad at the exit of the construction Site to mitigate sediment transport off-site;
- Straw bale barriers;
- Dewatering filter bags; and
- Temporary vegetation/seeding/hydroseeding/terraseeding.

The controls should be maintained until construction has been completed and the Site has been stabilized.

Erosion and Sediment Control measures shall be inspected within 24 hours after every significant rainfall event (greater than 10 mm) and maintained/repaired as required. The outlet on the south side of the Site should also be inspected for signs of sediment migration off-site. The monitoring program shall consist of visual inspections and a written log.

5.0 Conclusion

This Surface Water Assessment Report describes how the facility design and mitigation measures will be implemented to minimize adverse effects on the surrounding environment. Stormwater from the Site will flow overland to a bio-swale on the south/southeast side of the Project Location. The bio-swale will provide quality control for the runoff before it infiltrates or continues overland off the Project Location. Measures will also be implemented during the construction and decommissioning phases to minimize erosion and sediment transport.

Neegan Burnside Ltd. has prepared this Surface Water Assessment Report for Whitesand First Nation in accordance with O.Reg. 359/09. This report has been prepared by Burnside for the sole benefit of Whitesand First Nation, and may not be re-produced by any third party without the express written consent of Whitesand First Nation.

Respectfully submitted,

Neegan Burnside Ltd.

Written by:

Signature ______________________ Date October, 2014
Oliver Feniak, B.Sc., E.I.T.
Stormwater Management Engineering Assistant

Reviewed by:

Signature ______________________ Date October, 2014
Dan Miller, P.Eng.
Senior Stormwater Management Engineer

REGISTERED PROFESSIONAL ENGINEER
D.R. MILLER
14/10/24
PROVINCE OF ONTARIO

Signature ______________________ Date October, 2014
Chris Shilton, P.Eng., LEED ®AP
Project Manager

Approved By:

Signature ______________________ Date October, 2014
Craig Toset
Project Manager
Whitesand First Nation

Appendix A

Figures

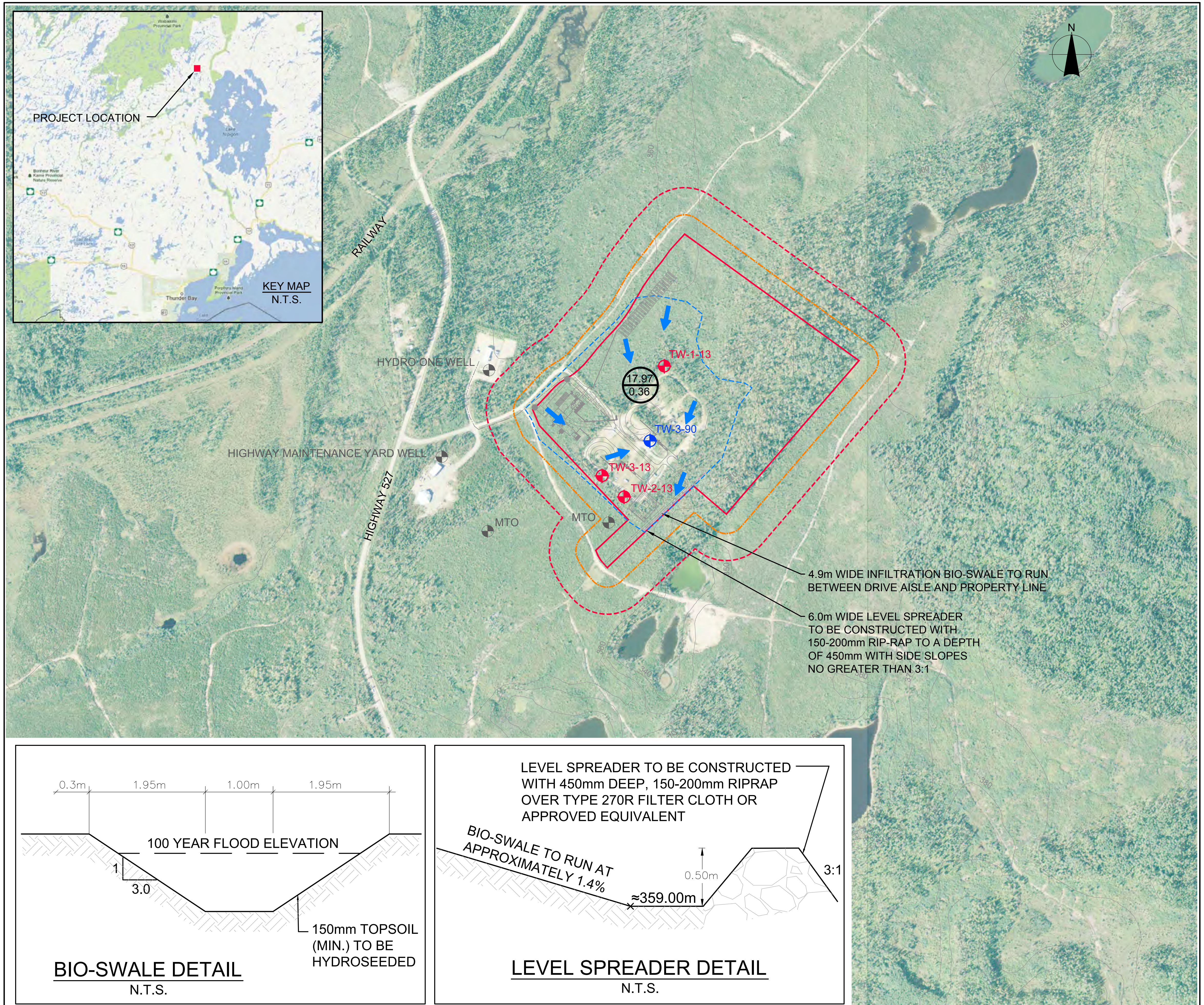


FIGURE A1

WHITESAND FIRST NATION

COGENERATION & PELLET MILL PROJECT

SURFACE WATER ASSESSMENT REPORT

STORMWATER MANAGEMENT PLAN

LEGEND

PROJECT LOCATION

STUDY AREA 50m SETBACK

STUDY AREA 120m SETBACK

MONITORING WELL LOCATION
By Others, 1990

MONITORING WELL LOCATION
By Neegan Burnside, 2013

PRIVATE WELL LOCATION
By Others

EXISTING ELECTRICITY DISTRIBUTION LINE

CONNECTION POINT

350 EXISTING 10m CONTOURS INTERVAL (m asl)

DRAINAGE AREA TO BIO-SWALE

OVERLAND FLOW DIRECTION

17.97 / 0.36 AREA (ha)
RUN-OFF COEFFICIENT

Air Photo Source:
Background 2008 forest resource inventory air photo reproduced with the permission of Ministry of Natural Resources, © Queen's Printer for Ontario

0 200 400 600 800
Metres

1:10,000
August 2014
Project Number: 300030895

Projection: UTM Zone 16
Datum: NAD83

Prepared by: C. Sheppard

Verified by: C. Shilton

NEEGAN BURNSIDE

030895 PELLET MILL DRAWING SET.DWG

LAYOUT: SURFACE WATER SWM

PRINTED: August 25, 2014, 4:20 PM

Conceptual Facility Design

Appendix B

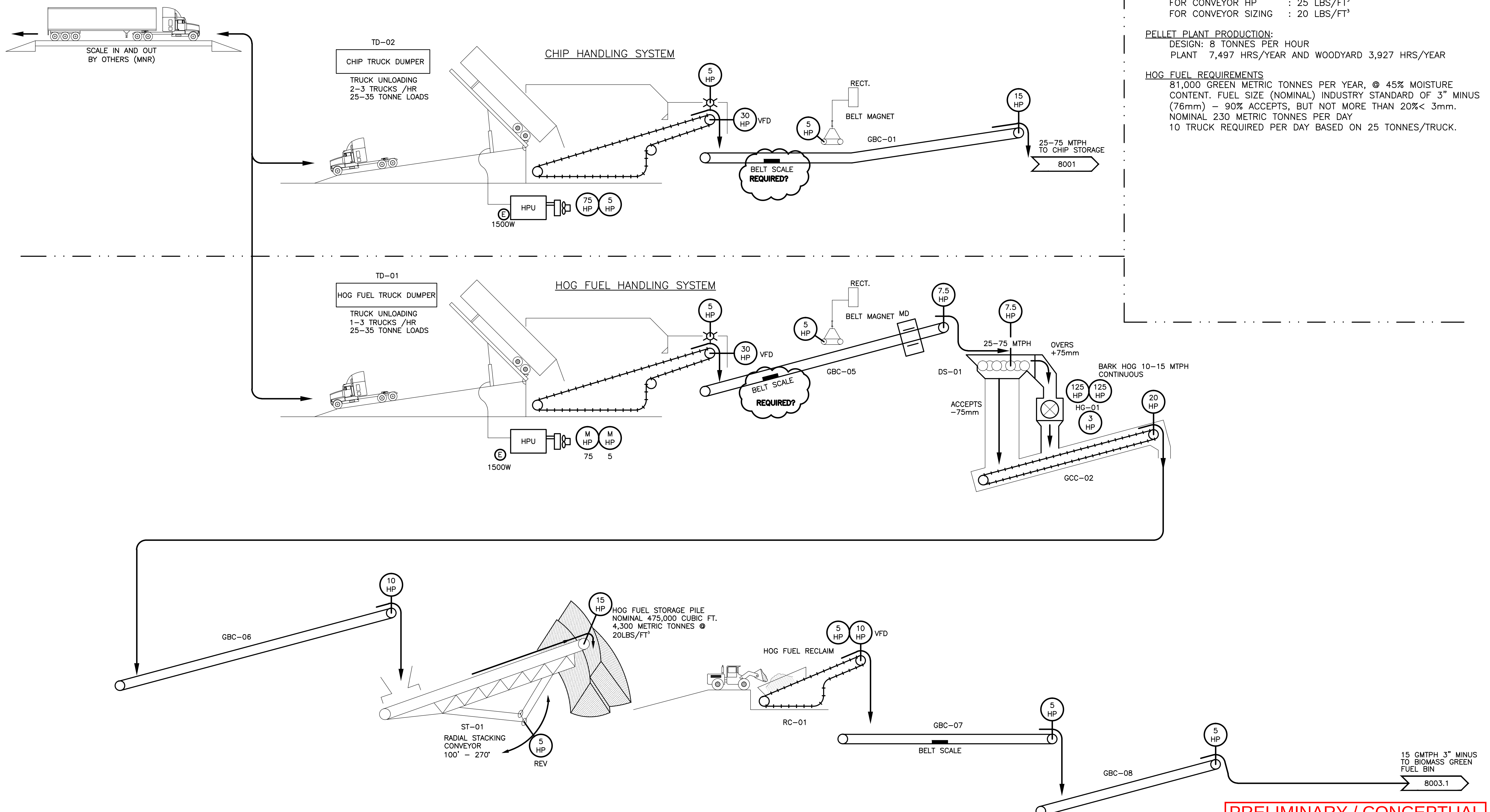
OPERATING PARAMETERS

FEED STOCK:
ASPEN 74%
WHITE BIRCH 26%
TOTAL 113,000 m^3 PER YEAR
CHIPS ARE TO BE SUPPLIED TO PULP MILL SPEC.

BIOMASS BULK DENSITY ASSUMPTIONS
FOR STORAGE : 20 LBS/FT^3
FOR CONVEYOR HP : 25 LBS/FT^3
FOR CONVEYOR SIZING : 20 LBS/FT^3

PELLET PLANT PRODUCTION:
DESIGN: 8 TONNES PER HOUR
PLANT 7,497 HRS/YEAR AND WOODYARD 3,927 HRS/YEAR

HOG FUEL REQUIREMENTS
81,000 GREEN METRIC TONNES PER YEAR, @ 45% MOISTURE CONTENT. FUEL SIZE (NOMINAL) INDUSTRY STANDARD OF 3" MINUS (76mm) – 90% ACCEPTS, BUT NOT MORE THAN 20%< 3mm.
NOMINAL 230 METRIC TONNES PER DAY
10 TRUCK REQUIRED PER DAY BASED ON 25 TONNES/TRUCK.



PRELIMINARY / CONCEPTUAL

DWG. NO.	DESCRIPTION
REFERENCES	

REV.	YYYY/MM/DD	DESCRIPTION	DRAFTER	DESIGNER	PROJ.MGR
J	2014/03/11	SYSTEM REVISED TO PURCHASED CHIPS AND BARK ONLY.	RMP		
H	2013/11/05	REVISED TRUCK DUMPER NOTES , ADDED BELT SPEED & CHIPPER RPM	TJH		
G	2013/09/18	REVISED TO INDICATE GTPH	TJH		
F	2013/08/19	REVISED TO MATCH SITE LAYOUT PLAN	TJH	TKK	DRW
E	2013/06/24	GENERAL REVISION	DTP	CPB	DRW
D	2013/06/05	WAS 2-3 TRUCKS/HR	DTP	CPB	DRW
C	2013/05/30	FOR REVIEW	JJR	DRW	DRW
B	2012/04/12	REVISED CHIP FLOW RATE	DCH	DRW	DRW
A	2012/03/26	FOR REVIEW	DCH	DRW	DRW

REVISIONS

ISSUE STATUS
FOR REVIEW

SCALE: N.T.S.

	INITIALS	YYYY/MM/DD
DESIGNED BY:	DRW	2012/02/10
DESIGN CHK'D. BY:	DRW	
DRAWN BY:	MJE	2012/02/24
DRAWING CHK'D. BY:		
PROJECT MANAGER	DRW	

KEYWORD

GNBE Great North Bio Energy

GENIVAR
740 SOUTH SYNDICATE AVENUE
THUNDER BAY, ONTARIO P7E 1E9
www.GENIVAR.com
TEL: 807 625-6700
FAX: 807 623-4491

GENIVAR REF. NO. 121-12538-01

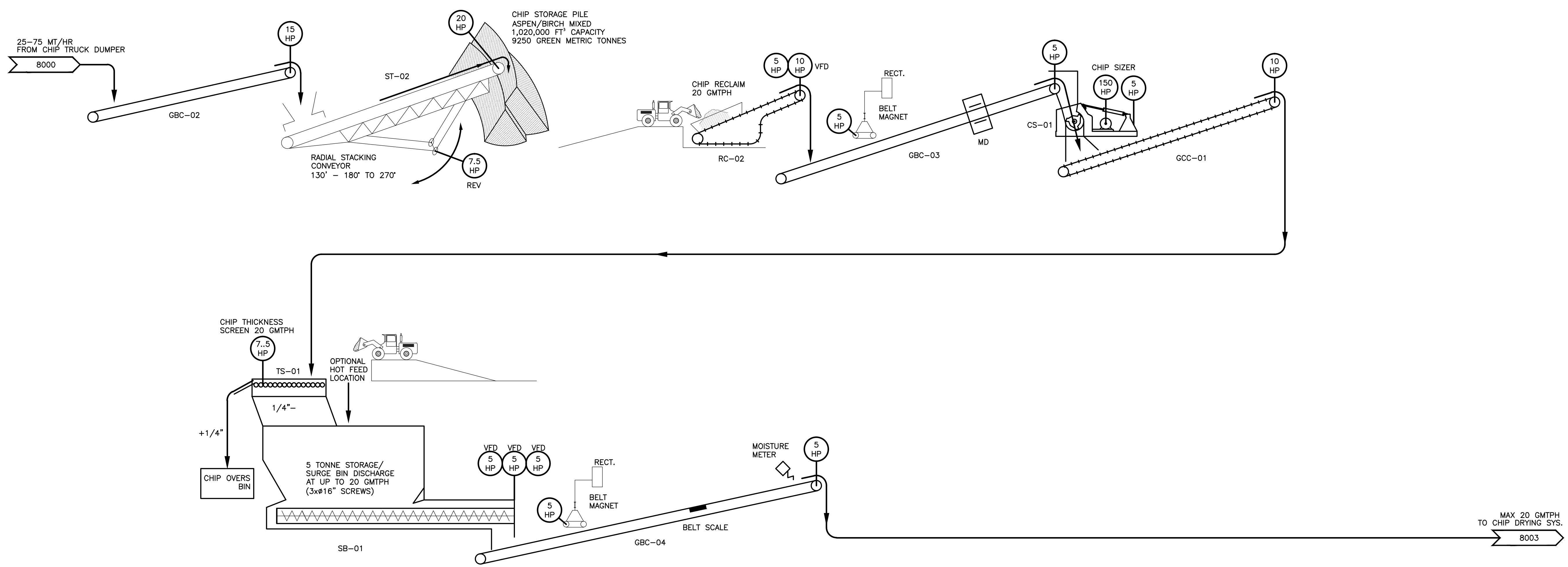
PROJECT: GREAT NORTH BIO ENERGY – WHITESAND F.N.

PROJECT NO.

TITLE: FLOW DIAGRAM
PRIMARY WOOD YARD
WHITESAND F.N. – COGEN/PELLET PLANT

CLIENT DWG. NO. 8000 J

FILE NAME: 121-12538-01 PID'S
LAST EDITED: 3/21/2014 11:33 AM



PRELIMINARY / CONCEPTUAL

DWG. NO.	DESCRIPTION	REV.	YYYY/MM/DD	DESCRIPTION	DRAFTER	DESIGNER	PROJ.MGR
		J	2014/03/11	SYSTEM REVISED TO PURCHASED CHIPS ONLY	RMP		
		H	2013/11/04	REVISED SCREEN	TJH		
		G	2013/09/18	REVISED TO 3/8" CHIPS AND GTPH, ADD CONVEYOR	TJH		
		F	2013/08/19	REVISED TO MATCH SITE LAYOUT	TJH	TKK	DRW
		E	2013/06/24	GENERAL REVISION, WAS DWG 8002	DTP	CPB	DRW
		D	2013/06/05	WAS 15 MTPH	DTP	CPB	DRW
		C	2013/05/30	FOR REVIEW	JJR	DRW	DRW
		B	2012/04/12	REVISED FLOW RATE	DCH	DRW	DRW
		A	2012/03/26	FOR REVIEW	DCH	DRW	DRW

REFERENCES — REVISIONS

ISSUE STATUS

FOR REVIEW

SCALE: N.T.S.

	INITIALS	YYYY/MM/DD
DESIGNED BY:	DRW	2012/02/10
DESIGN CHK'D. BY:	DRW	
DRAWN BY:	MJE	2012/02/24
DRAWING CHK'D. BY:		
PROJECT MANAGER	DRW	

KEYWORD

GNBE Great North Bio Energy

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GENIVAR REF. NO. 121–12538–01

PROJECT: GREAT NORTH BIO ENERGY – WHITESAND F.N.

PROJECT NO.

TITLE: FLOW DIAGRAM
PROCESSING WOOD YARD
WHITESAND F.N. – COGEN/PELLET PLANT

CLIENT DWG. NO. 8001 J

FILE NAME: 121–12538–01 PID'S
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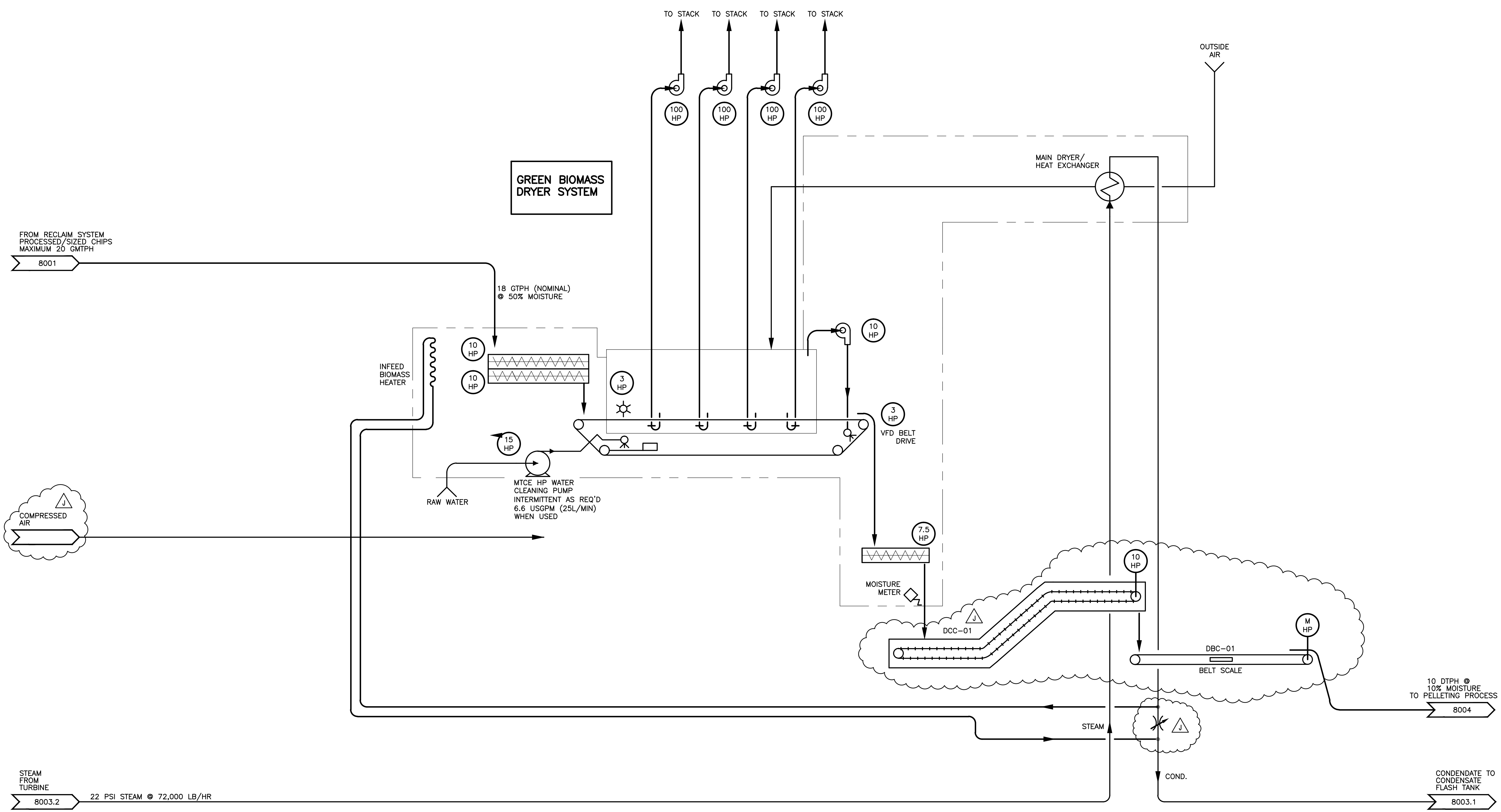

PRELIMINARY / CONCEPTUAL

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		J	2013/11/08	REVISED CONVEYORS	TJH/SvT	TKK	DRW
		I	2013/09/26	REVISED TO INDICATE GTPH & DTPH	TJH	TKK	DRW
		H	2013/08/19	WAS COND. TO BOILER	DTP	TKK	DRW
		G	2013/08/06	GENERAL REVISIONS	JJR	CPB	DRW
		F	2013/07/17	DWG NO WAS 8003 NOW IS 8003.1	DTP	CPB	DRW
		E	2013/06/24	GENERAL REVISION, DWG NO WAS 8004	DTP	CPB	DRW
		D	2012/06/05	ADD HEAT EXCHANGER AND PROCESS	DTP	CPB	DRW
		C	2013/05/30	FOR REVIEW	JJR	DRW	DRW
013/08/16		B	2012/03/28	REVISED STEAM & CONDENSATE FLOW	DCH	DRW	DRW
		A	2012/03/26	FOR REVIEW	DCH	DRW	DRW

REFERENCES — REVISIONS

ISSUE STATUS

FOR REVIEW

SCALE: N.T.S.

	INITIALS	YYYY/MM/DD
DESIGNED BY:	RW	2012/02/10
DESIGN CHK'D. BY:	DRW	
DRAWN BY:	MJE	2012/02/24
DRAWING CHK'D. BY:		
PROJECT MANAGER	DRW	

KEYWORD

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GENIVAR REF. NO. 121-12538-01

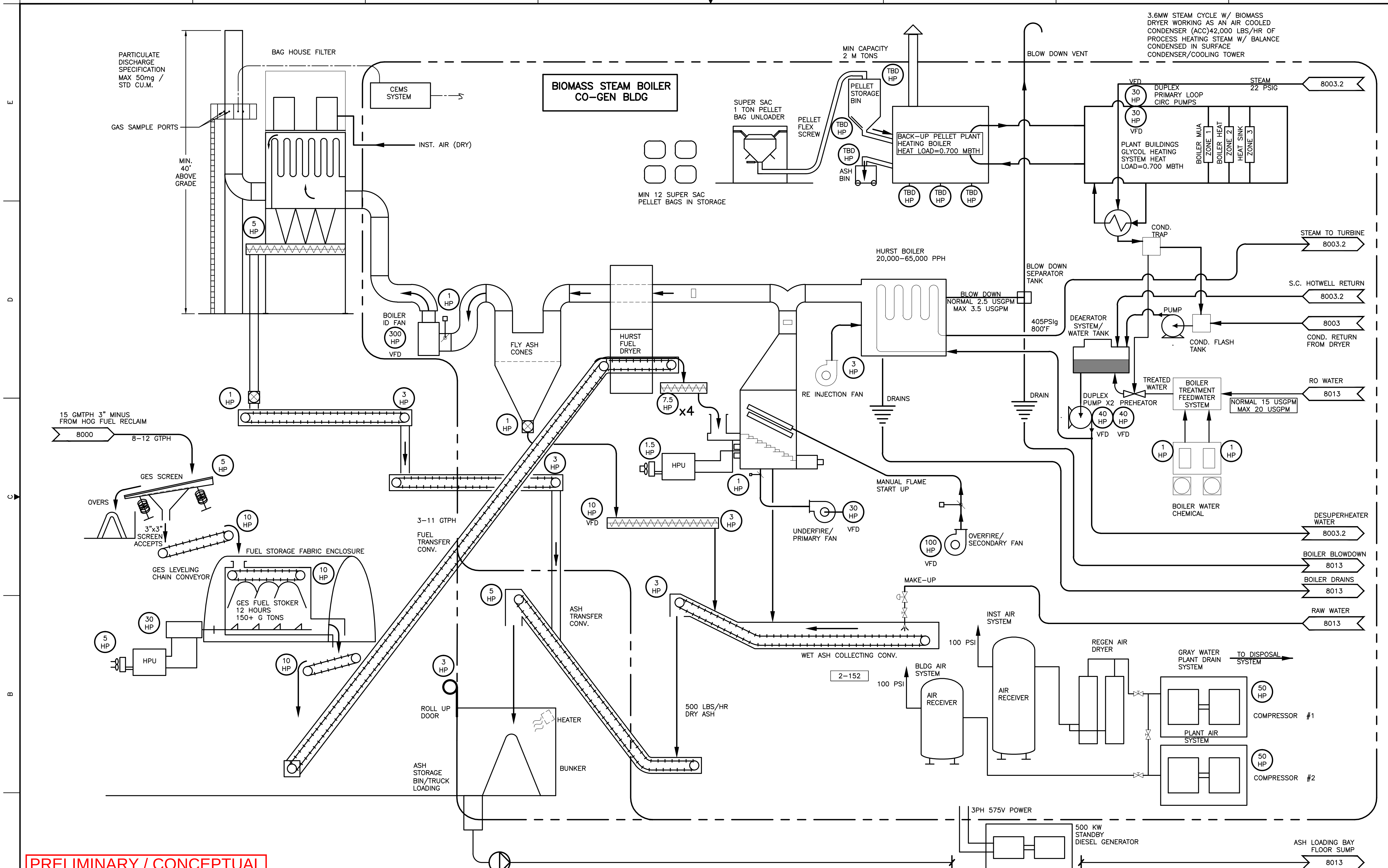
PROJECT: GREAT NORTH BIO ENERGY – WHITESAND F.N.

PROJECT NO.

TITLE: FLOW DIAGRAM
GREEN BIOMASS BELT DRYER
WHITESAND F.N. – COGEN/PELLET PLANT

CLIENT DWG. NO. 8003 J

FILE NAME: 121-12538-01 PID'S
LAST EDITED: 3/21/2014 11:33 AM



PRELIMINARY / CONCEPTUAL

DWG. NO.	DESCRIPTION	REV.	YYYY/MM/DD	DESCRIPTION	DRAFTER	DESIGNER	PROJ.MGR
		I	2014/03/12	ADDED NOTES, GENERAL REVISIONS	TJH		
		H	2013/09/24	REVISED TO INDICATE GTPH	TJH	TKK	DRW
		G	2013/08/21	ADD DRAINS, FLOW, OFFSHEET DIRECTION	DTP	TKK	DRW
		F	2013/08/19	ADD SUPER SAC UNLOADER SYS, HURST FUEL DRYER	DTP	TKK	DRW
		E	2013/06/24	GENERAL REV, DWG NO WAS 8004.1, WAS 405 PSIG/770°F, ADD PUMPS	DTP	CPB	DRW
		D	2013/06/05	ISSUED FOR REVIEW	DTP	CPB	DRW
		C	2013/05/30	FOR REVIEW	JJR	DRW	DRW
		B	2012/03/28	FOR REVIEW	DCH	DRW	DRW
		A	2012/03/26	FOR REVIEW	DCH	DRW	DRW
REFERENCES		REVISIONS					

ISSUE STATUS: **FOR REVIEW**

SCALE: N.T.S.

	INITIALS	YYYY/MM/DD
DESIGNED BY:	DRW/TKK	2012/03/15
DESIGN CHK'D. BY:	DRW	TKK
DRAWN BY:	DCH/DTP	2012/03/14
DRAWING CHK'D. BY:	TKK	
PROJECT MANAGER	DRW	

KEYWORD

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GENIVAR REF. NO. 121-12538-01

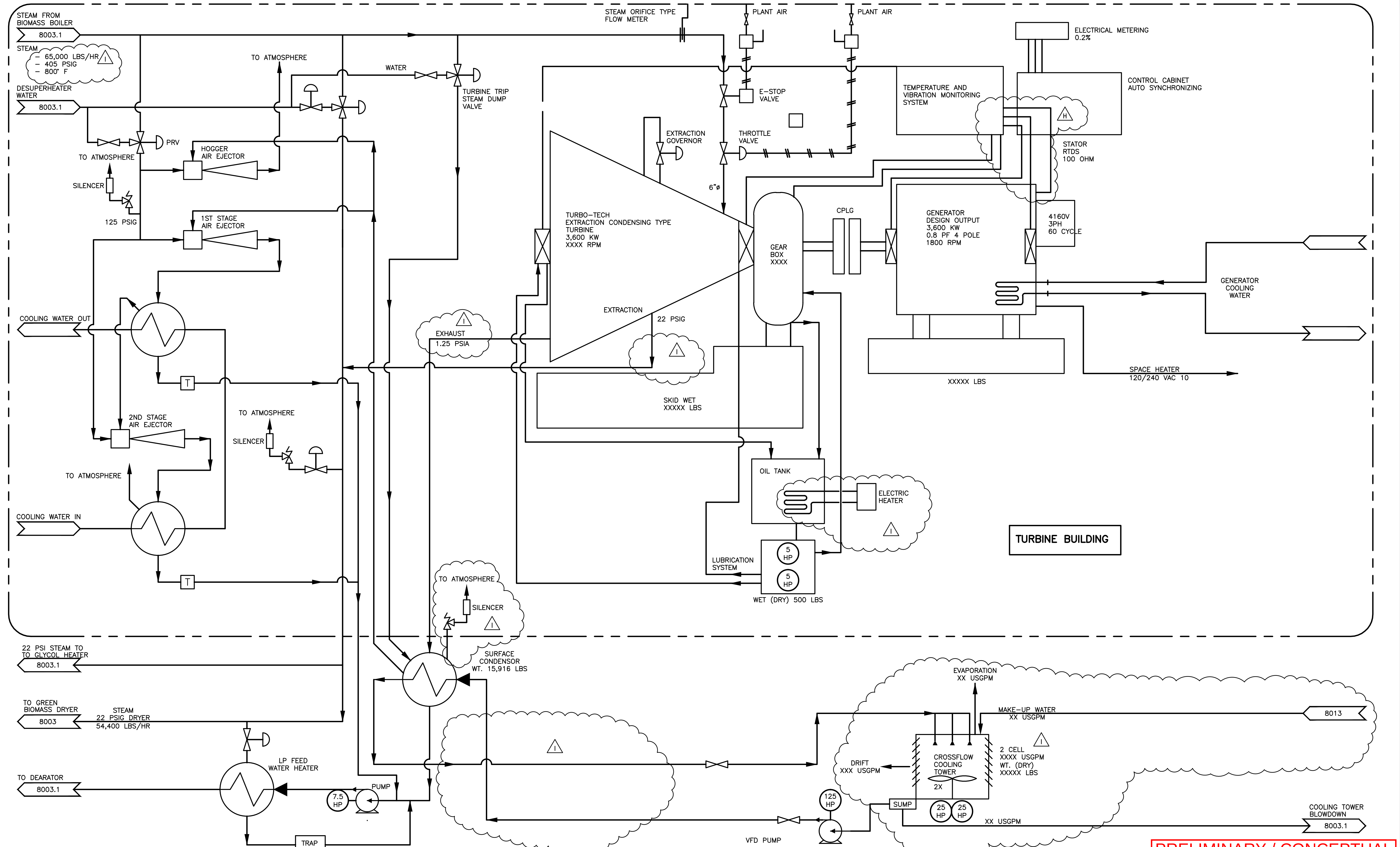
PROJECT: GREAT NORTH BIO ENERGY – WHITESAND F.N.

PROJECT NO.

TITLE: FLOW DIAGRAM
BIOMASS FURNACE & STEAM BOILER SYSTEM
WHITESAND F.N. – COGEN/PELLET PLANT

CLIENT DWG. NO. 8003.1 (I)

FILE NAME: 121-12538-01 PID'S
LAST EDITED: 3/21/2014 11:33 AM



PRELIMINARY / CONCEPTUAL

DWG. NO.	DESCRIPTION	REV.	YYYY/MM/DD	DESCRIPTION	DRAFTER	DESIGNER	PROJ.MGR
		I		GENERAL REVISION	TJH		
		H	2013/09/24	ADD COOL'G TOWER BLOWDOWN	TJH	TKK	DRW
		G	2013/08/19	REVISED TO MATCH SITE PLAN	TJH/DTP	TKK	DRW
		F	2013/07/17	COMPLETED CIRCUITS FOR GLYCOL HTG SYSTEM AND COOL'G TOWER	DTP	TKK	DRW
		E	2013/06/24	GENERAL REVISION, DWG NO WAS 8004.2	DTP	CPB	DRW
		D	2013/06/05	ISSUED FOR REVIEW	DTP	CPB	DRW
		C	2013/05/30	FOR REVIEW	JJR	DRW	DRW
		A	2012/03/27	FOR REVIEW	DCH	DRW	DRW
REFERENCES		REVISIONS					

ISSUE STATUS
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SCALE
N.T.S.

	INITIALS	YYYY/MM/DD
DESIGNED BY:	DRW	2012/03/15
DESIGN CHK'D. BY:	DRW	
DRAWN BY:	DCH	2012/03/14
DRAWING CHK'D. BY:		
PROJECT MANAGER	DRW	

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GENIVAR REF. NO. 121–12538–01

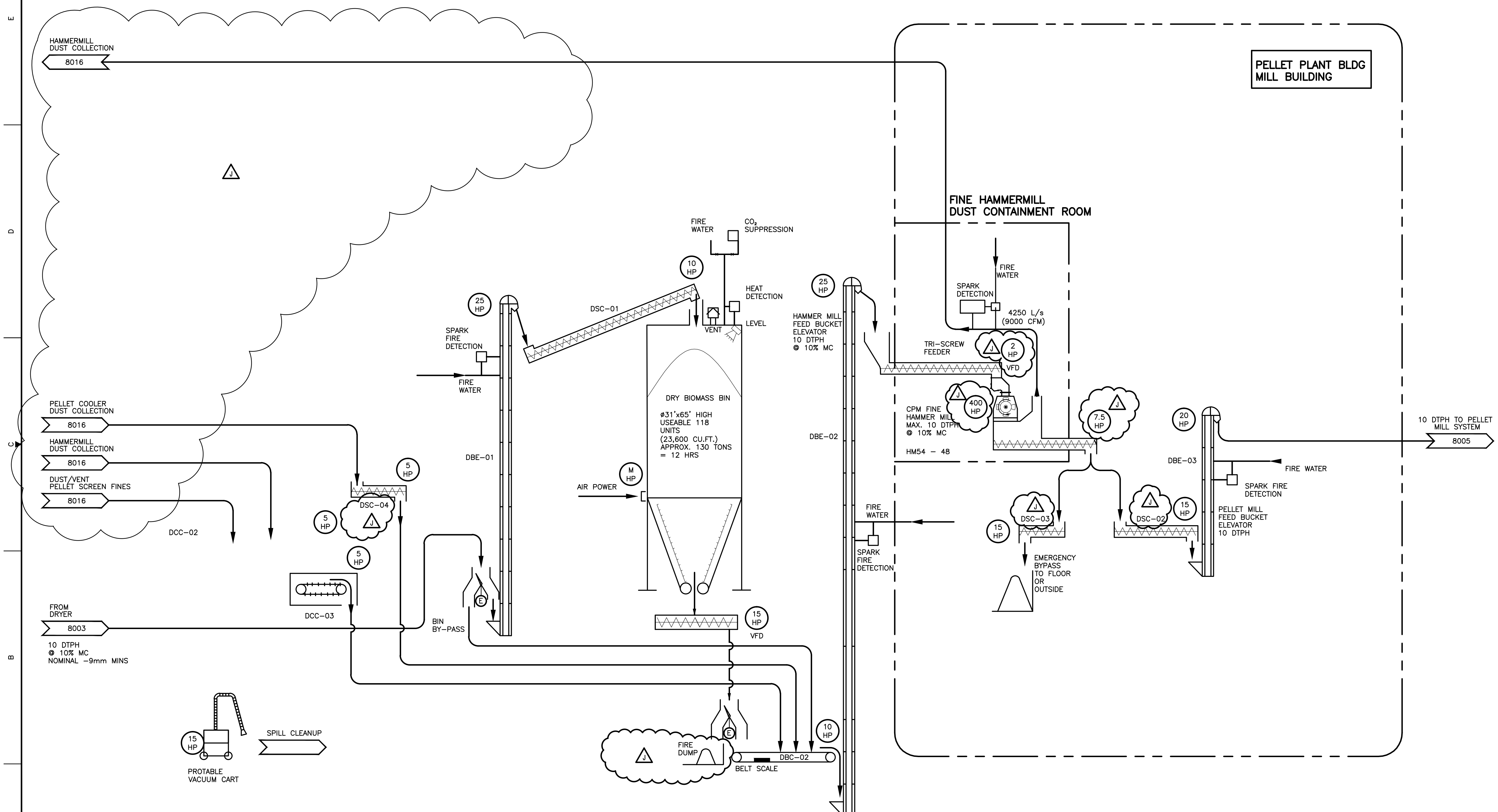
PROJECT
GREAT NORTH BIO ENERGY – WHITESAND F.N.

PROJECT NO.

TITLE
FLOW DIAGRAM
4.3 MW STEAM TURBINE SYSTEM
WHITESAND F.N. – COGEN/PELLET PLANT

CLIENT DWG. NO. 8003.2 I

FILE NAME: 121–12538–01 PID'S
LAST EDITED: 3/21/2014 11:33 AM



PRELIMINARY / CONCEPTUAL

		REV.	YYYY/MM/DD	DESCRIPTION	DRAFTER	DESIGNER	PROJ.MGR
		J	2014/03/12	REMOVED DUST COLLECTION EQUIPMENT SEE DWG. 121-12538-01-8016	TJH	TKK	TKK
		H	2013/11/08	REVISED CONVEYORS	TJH/SvT	TKK	DRW
		G	2013/09/24	REVISED TO INDICATE DTPH	TJH	TKK	DRW
		F	2013/08/19	REVISED TO MATCH SITE PLAN LAYOUT	TJH/DTP	TKK	DRW
		E	2013/06/24	GENERAL REVISION, DWG NO WAS 8005	DTP	CPB	DRW
		D	2013/06/05	WAS FINE DUMP	DTP	CPB	DRW
		C	2013/05/30	FOR REVIEW	JJR	DRW	DRW
		B	2012/03/28	FOR REVIEW	DCH	DRW	DRW
		A	2012/03/26	FOR REVIEW	DCH	DRW	DRW
DWG. NO.	DESCRIPTION						
REFERENCES		REVISIONS					

ISSUE STATUS

FOR REVIEW

SCALE: N.T.S.

	INITIALS	YYYY/MM/DD
DESIGNED BY:	DRW	2012/02/10
DESIGN CHK'D. BY:	DRW	
DRAWN BY:	MJE	2012/02/24
DRAWING CHK'D. BY:		
PROJECT MANAGER	DRW	

KEYWORD

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GENIVAR REF. NO. 121-12538-01

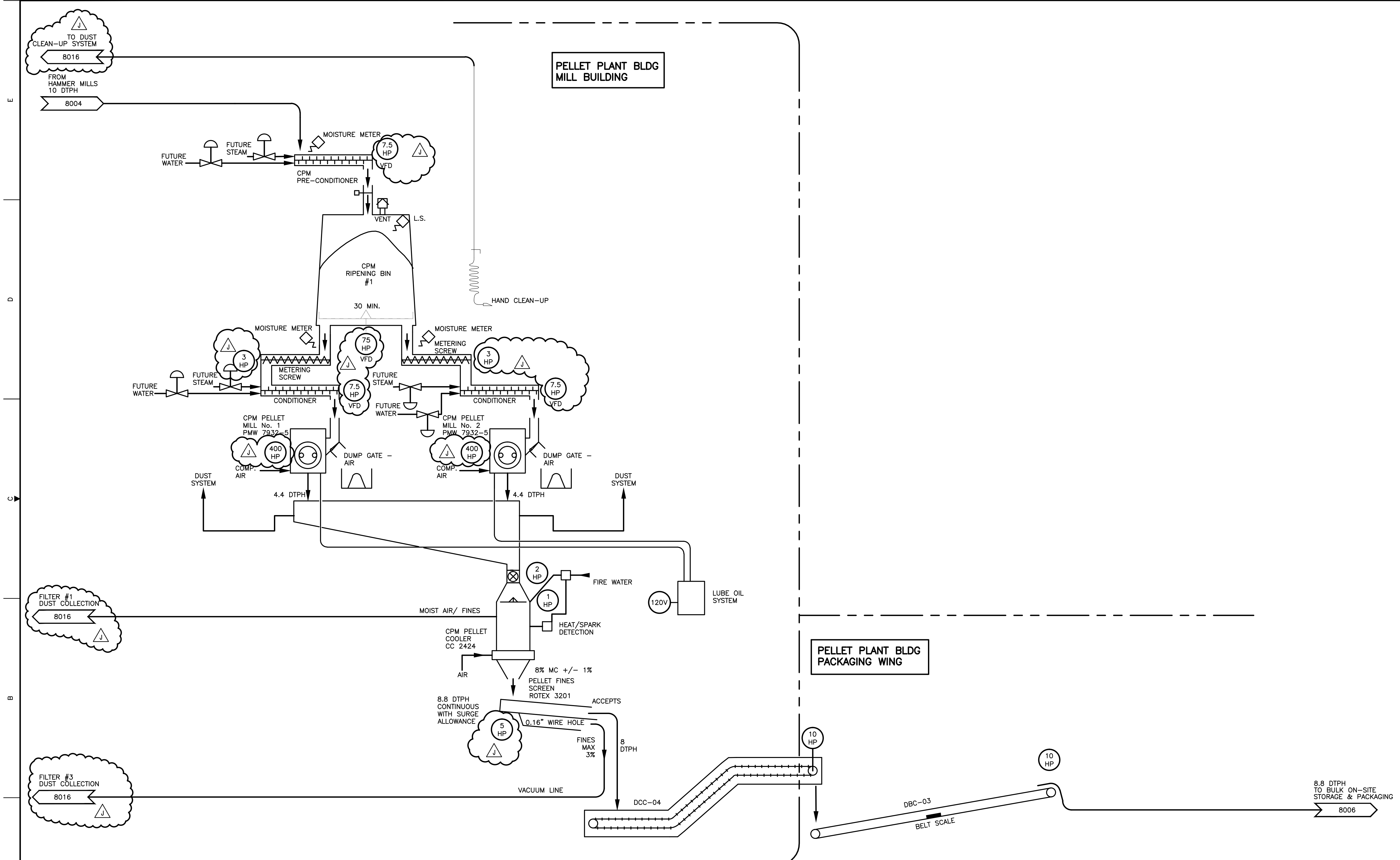
PROJECT: GREAT NORTH BIO ENERGY - WHITESAND F.N.

PROJECT NO.

TITLE: FLOW DIAGRAM
FINE HAMMER MILL
WHITESAND F.N. - COGEN/PELLET PLANT

CLIENT DWG. NO. 8004

FILE NAME: 121-12538-01 PID'S
LAST EDITED: 3/21/2014 11:33 AM



PRELIMINARY / CONCEPTUAL

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		H	2013/11/08	REVISED CONVEYORS	TJH/SvT	TKK	DRW
		G	2013/09/24	REVISED TO INDICATE DTPH	TJH	TKK	DRW
		F	2013/08/16	REVISED TO MATCH SITE PLAN LAYOUT	TJH/DTP	TKK	DRW
		E	2013/06/24	GENERAL REVISION, DWG NO WAS 8006	DTP	CPB	DRW
		D	2013/06/05	ISSUED FOR REVIEW	DTP	DRW	DRW
		C	2013/05/30	FOR REVIEW	JJR	DRW	DRW
		B	2012/03/28	FOR REVIEW	DCH	DRW	DRW
		A	2012/03/26	FOR REVIEW	DCH	DRW	DRW
REFERENCES		REVISIONS					

ISSUE STATUS
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	INITIALS	YYYY/MM/DD
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DRAWN BY:	MJE	2012/02/24
DRAWING CHK'D. BY:		
PROJECT MANAGER	DRW	

KEYWORD

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GENIVAR REF. NO. 121-12538-01

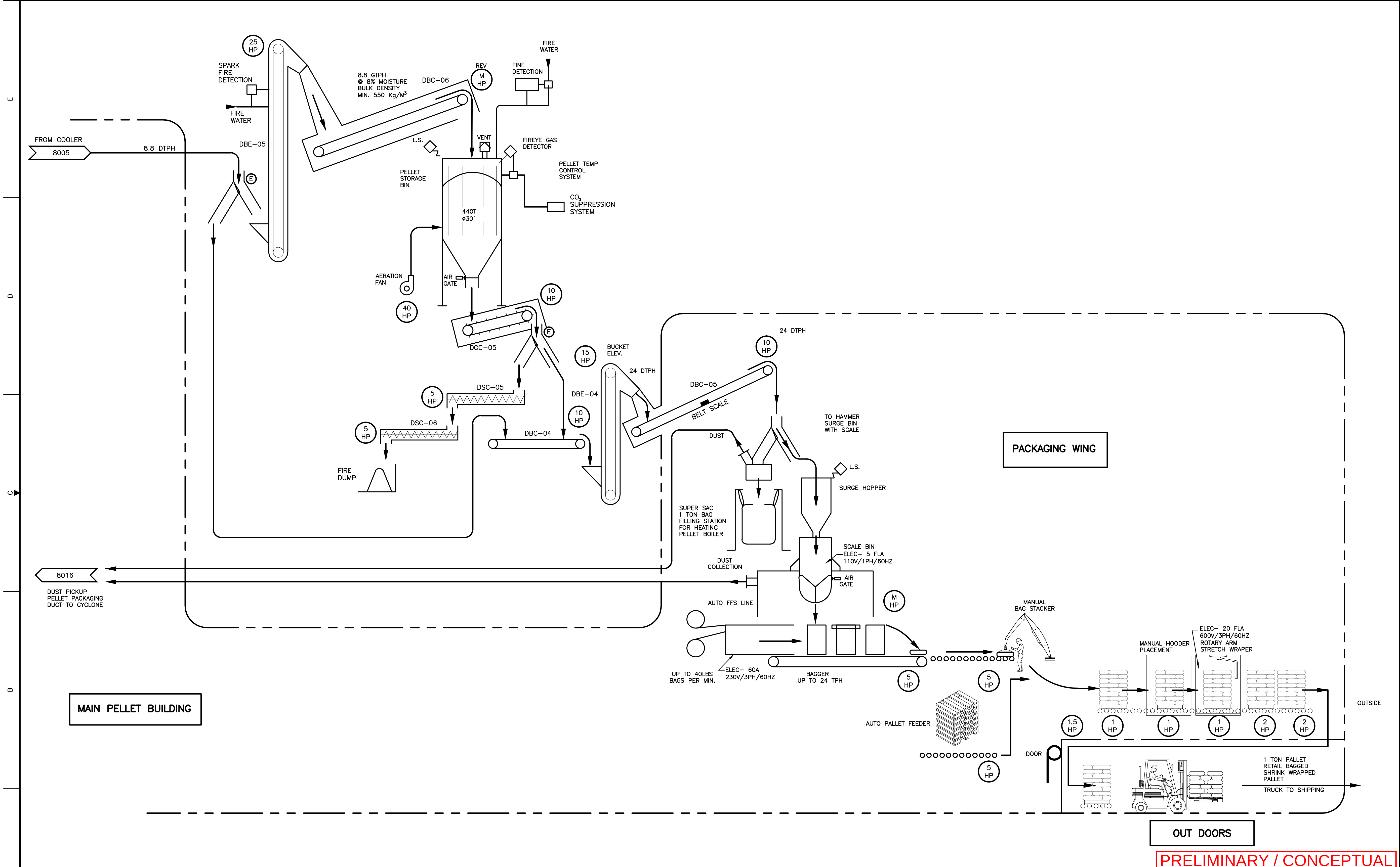
PROJECT: GREAT NORTH BIO ENERGY – WHITESAND F.N.

PROJECT NO.

TITLE: FLOW DIAGRAM PELLETING WHITESAND F.N. – COGEN/PELLET PLANT

CLIENT DWG. NO. 8005 J

FILE NAME: 121-12538-01 PID'S
LAST EDITED: 3/21/2014 11:33 AM



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		G	2013/09/24	REVISED TO INDICATE GTPH	TJH	TKK	DRW
		F	2013/08/19	REVISED TO MATCH SITE PLAN LAYOUT	TJH/DTP	TKK	DRW
		E	2013/06/24	GENERAL REVISION, DWG NO WAS 8007	DTP	CPB	DRW
		D	2013/06/05	ISSUED FOR REVIEW	DTP	DRW	DRW
		C	2013/05/30	FOR REVIEW	JJR	DRW	DRW
		B	2012/03/28	FOR REVIEW	DCH	DRW	DRW
		A	2012/03/26	FOR REVIEW	DCH	DRW	DRW
REFERENCES		REVISIONS					

ISSUE STATUS

FOR REVIEW

SCALE N.T.S.

	INITIALS	YYYY/MM/DD
DESIGNED BY:	DRW	2012/02/10
DESIGN CHK'D. BY:	DRW	
DRAWN BY:	MJE	2012/02/24
DRAWING CHK'D. BY:		
PROJECT MANAGER	DRW	

KEYWORD

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GENIVAR REF. NO. 121-12538-01

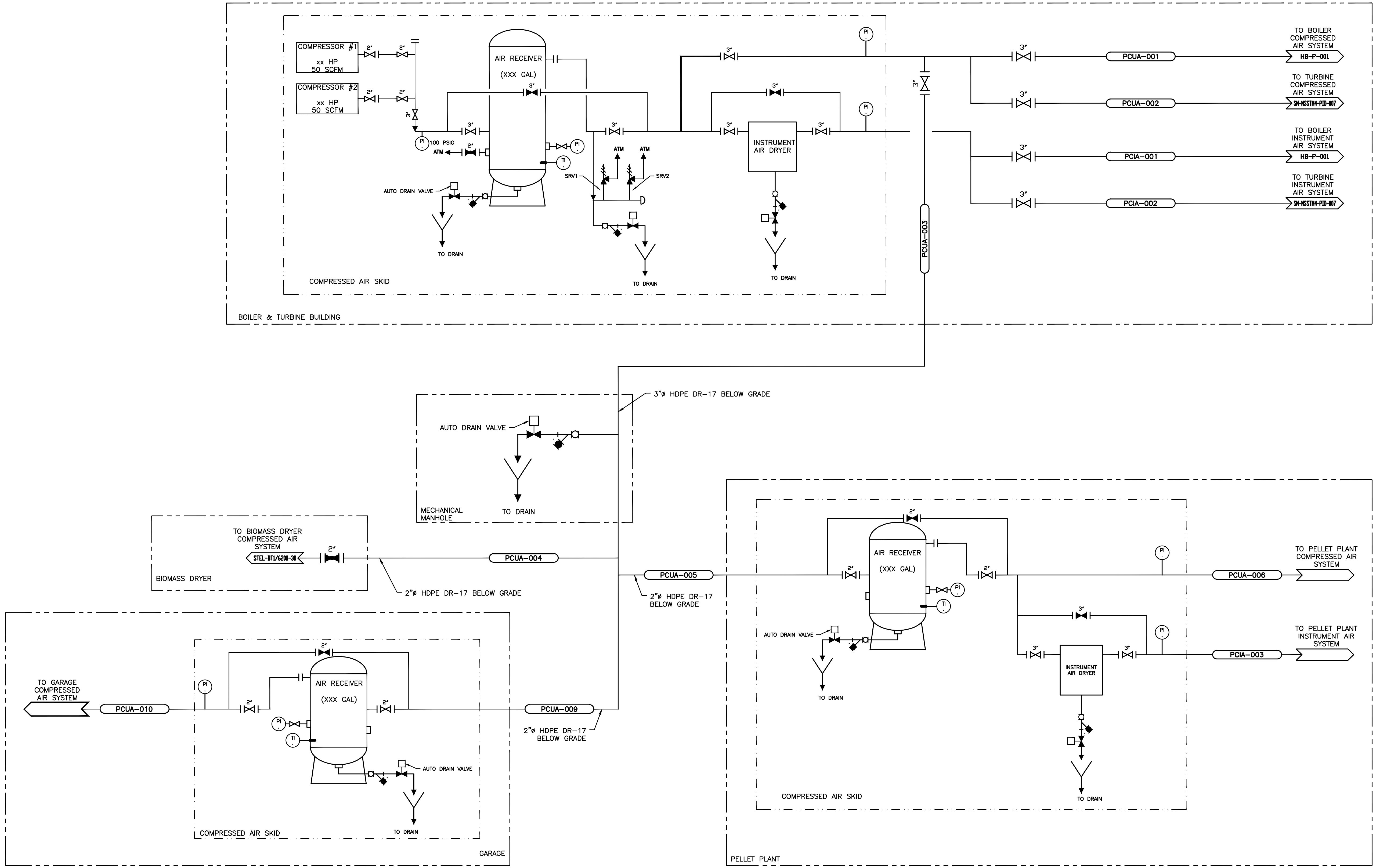
PROJECT: GREAT NORTH BIO ENERGY – WHITESAND F.N.

PROJECT NO.

TITLE: FLOW DIAGRAM
SITE PELLET PACKAGING
WHITESAND F.N. – COGEN/PELLET PLANT

CLIENT DWG. NO. 8006 H

FILE NAME: 121-12538-01 PID'S
LAST EDITED: 3/21/2014 11:33 AM



PRELIMINARY / CONCEPTUAL

DWG. NO.	DESCRIPTION	REV.	YYYY/MM/DD	DESCRIPTION	DRAFTER	DESIGNER	PROJ.MGR
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REFERENCES				REVISIONS			

ISSUE STATUS
PRELIMINARY

SCALE: N.T.S.

	INITIALS	YYYY/MM/DD
DESIGNED BY:	SvT	
DESIGN CHK'D. BY:		
DRAWN BY:	SvT	
DRAWING CHK'D. BY:		
PROJECT MANAGER		

KEYWORD

GNBE Great North Bio Energy

WSP

WSP REF. NO. 121-12538-00-8105

PROJECT: GREAT NORTH BIO ENERGY – WHITESAND F.N.

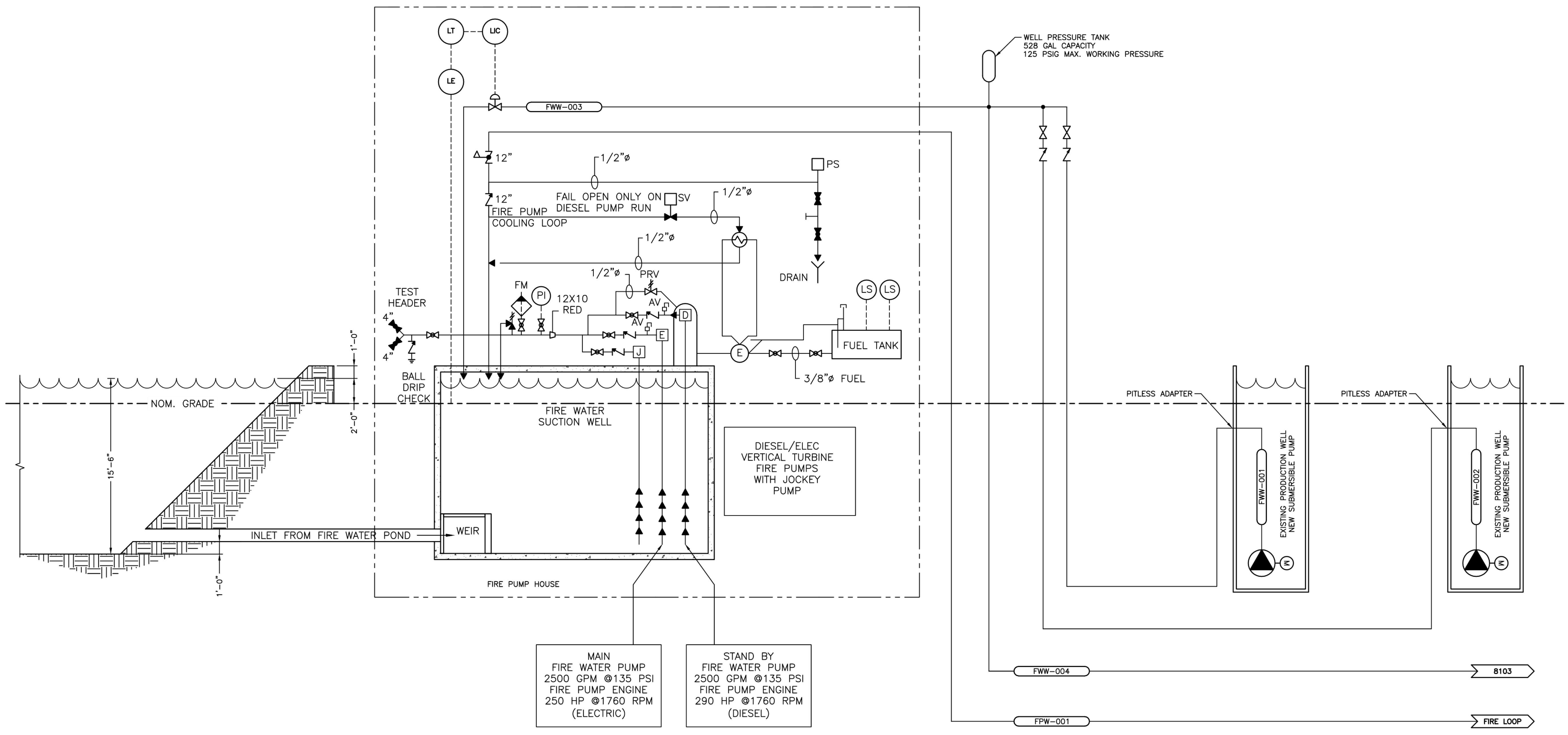
PROJECT NO.

TITLE: FLOW DIAGRAM COMPRESSED AIR

CLIENT DWG. NO.

A

FILE NAME: 121-12538-01-8105 REVA
LAST EDITED: 6/27/2014 11:17 AM



PRELIMINARY / CONCEPTUAL

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REFERENCES		REVISIONS					

ISSUE STATUS: **PRELIMINARY FOR PRICING**

SCALE: N.T.S.

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DESIGN CHK'D. BY:		
DRAWN BY:		
DRAWING CHK'D. BY:		
PROJECT MANAGER		

KEYWORD

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FAX: 807 623-4491

WSP REF. NO. 121-12538-01

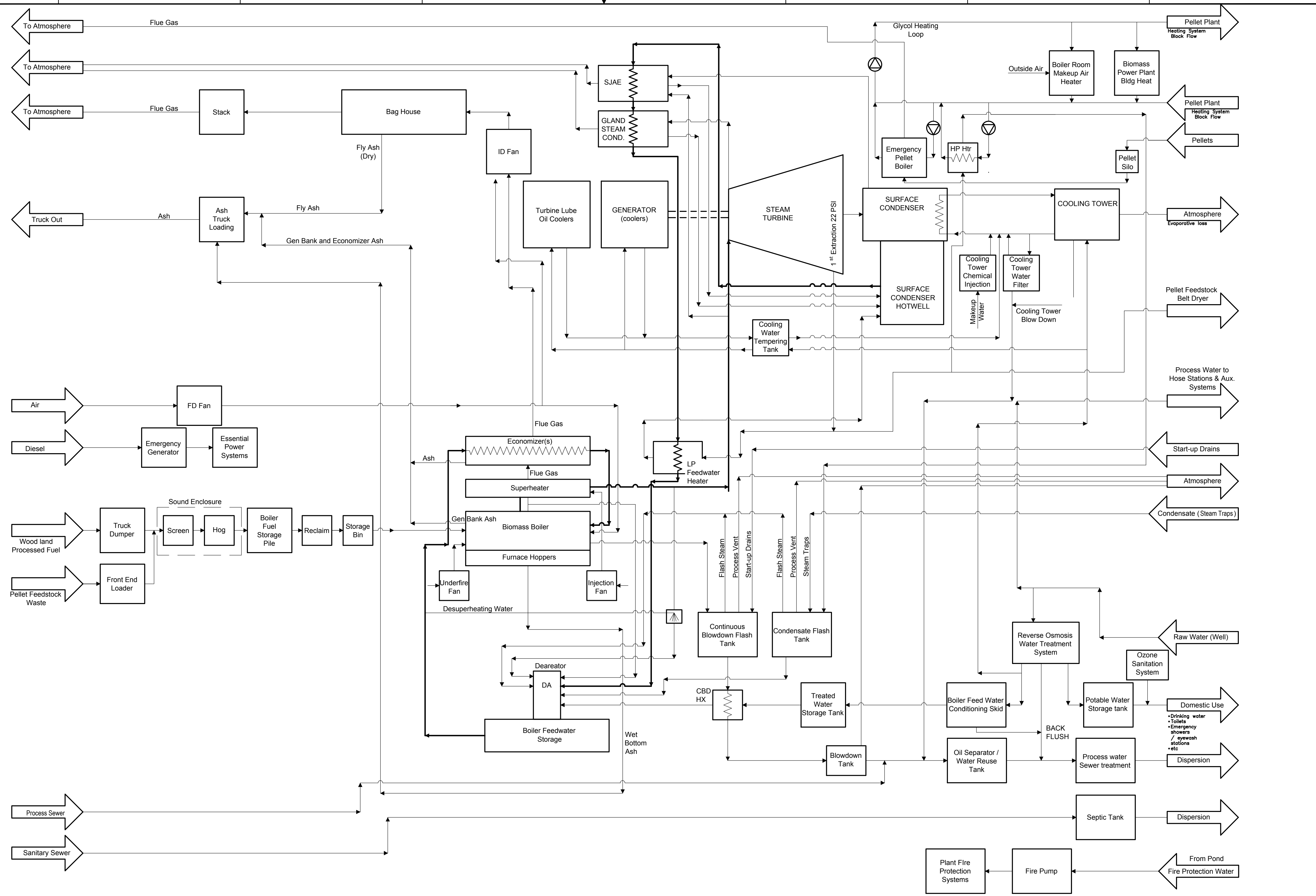
PROJECT: GREAT NORTH BIO ENERGY – WHITESAND F.N.

PROJECT NO.

TITLE: P & ID
FRESH WATER PIPING
WHITESAND F.N. – COGEN/PELLET PLANT

CLIENT DWG. NO. 8106 A

FILE NAME: 121-12538-01-8106 REVA
LAST EDITED: 7/11/2014 10:03 AM



PRELIMINARY / CONCEPTUAL

REV.	YYYY/MM/DD	DESCRIPTION	DRAFTER	DESIGNER	PROJ.MGR
B	2014/06/10	REVISED	TJH	TKK	
A	2013/08/12	FOR REVIEW	DTP	TKK	

DWG. NO. | DESCRIPTION — REFERENCES — REVISIONS

ISSUE STATUS
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SCALE N.T.S.

	INITIALS	YYYY/MM/DD
DESIGNED BY:	TKK	2013/07/23
DESIGN CHK'D. BY:	CPB	2013–08–26
DRAWN BY:	DTP	2013/07/23
DRAWING CHK'D. BY:	TKK	2013–08–27
PROJECT MANAGER	DRW	2013–08–28

KEYWORD

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WSP REF. NO. 121–12538–01–8010

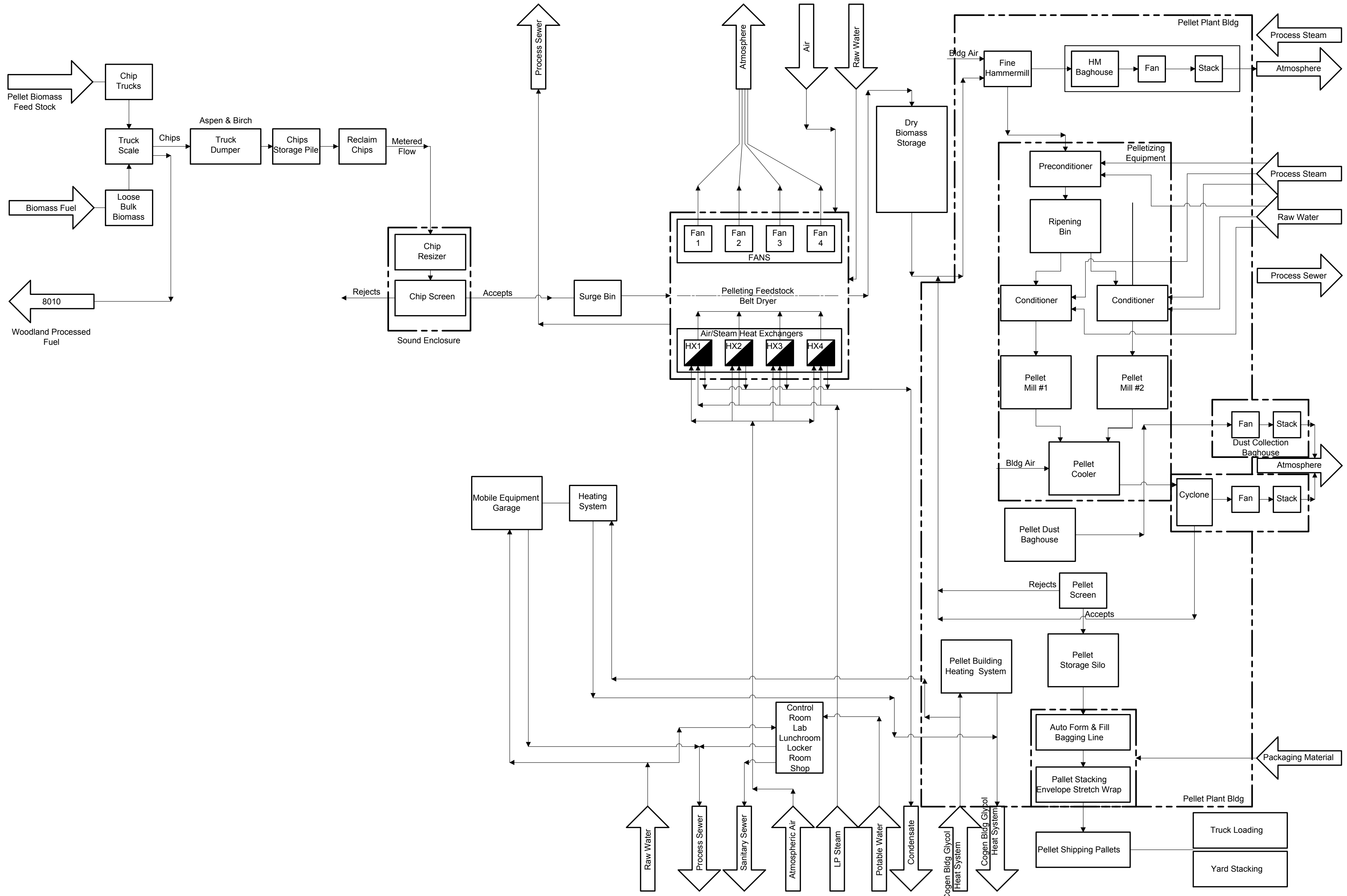
PROJECT GREAT NORTH BIO ENERGY – WHITESAND F.N.

PROJECT NO. 121–12538–01

TITLE PLANT PROCESS BLOCK DIAGRAM WHITESAND F.N. – COGEN/PELLET PLANT

CLIENT DWG. NO. B

FILE NAME: 121–12538–01–8010 REVA
LAST EDITED: 8/7/2014 3:57 PM



PRELIMINARY / CONCEPTUAL

REV.	YYYY/MM/DD	DESCRIPTION	DRAFTER	DESIGNER	PROJ.MGR
B	2014/06/10	REVISED	TJH	TKK	
A	2013/08/13	FOR REVIEW	DTP	DRW	

REVISIONS

DWG. NO.	DESCRIPTION

REFERENCES

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SCALE: N.T.S.

	INITIALS	YYYY/MM/DD
DESIGNED BY:	DRW	2013/07/12
DESIGN CHK'D. BY:	TKK	2013–08–19
DRAWN BY:	DTP	2013/08/13
DRAWING CHK'D. BY:	TKK	2013–08–28
PROJECT MANAGER	DRW	2013–08–29

KEYWORD

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WSP REF. NO. 121–12538–01–8011

PROJECT: GREAT NORTH BIO ENERGY – WHITESAND F.N.

PROJECT NO. 121–12538–01

TITLE: PELLET PLANT PROCESS BLOCK DIAGRAM WHITESAND F.N. – COGEN/PELLET PLANT

CLIENT DWG. NO.

B

FILE NAME: 121–12538–01–8011 REVA
LAST EDITED: 8/7/2014 4:34 PM

Stormwater Design Calculations

Appendix C

Project:	**Whitesands SWA**
Project #:	300030895
Designed By:	O. Feniak
Checked By:	D. Miller
Date:	25-Aug-2014

Airport Method for Time to Peak Calculations

Natural Area Watershed Information

WS	Area (ha)	Length (m)	RC	Slope (%)	Time of Concentration (min)
105	17.97	570	0.36	0.439	75.60

NOTE: Time to Peak = 0.60Tc

Tp = 45.36 mins

NOTE: Airport method was selected to calculate the watershed time of concentration as per the MOE Drainage Management Manual (for RC less than 0.4) - see below

Airport Formula

For watersheds where the runoff coefficient, C, is less than 0.40, the Airport formula gives a better estimate of t_c. This method was developed for airfields and is expressed as follows:

$$t_c = \frac{3.26 * (1.1 - C) * L^{0.5}}{S_w^{0.33}} \qquad (8.16)$$

where:

t_c = time of concentration, min
C = runoff coefficient
S_w = watershed slope, %
L = watershed length, m

Project: **Whitesand First Nation - Cogeneration Plant**
Project #: 300030895
Designed By: O. Feniak
Checked By: D. Miller
Date: 25-Aug-2014

BURNSIDE

Composite Runoff Coefficient Calculations

Pre-Development (existing)

Area ID	Area (m^2)	Area (ha)	RC	Area x RC
Gravel/Veg	64728	6.47	0.55	3.560
Vegetation	281438	28.14	0.25	7.036
Total:	346166	34.62		10.596

Composite RC: 0.31

Post Development

Area ID	Area (m^2)	Area (ha)	RC	Area x RC
Roof / Asphalt / Access Roads	27859	2.79	0.95	2.647
Vegetation	318307	31.83	0.25	7.958
Total:	346166	34.62		10.604

Composite RC: 0.31

Post Development - to Bio-Swale

Area ID	Area (m^2)	Area (ha)	RC	Area x RC
Roof / Asphalt / Access Roads	26999	2.70	0.95	2.565
Vegetation	152690	15.27	0.25	3.817
Total:	179689	17.97		6.382

Composite RC: 0.36

Project:	**Whitesands SWA**
Project #:	300030895
Designed By:	O. Feniak
Checked By:	D. Miller
Date:	25-Aug-2014

BURNSIDE

Post-Development Flows

Time of Concentration: 75 Minutes
Nearest City Centre: Armstrong Station
Runoff Coefficient: 0.36
Area: 17.97 ha.

2-year Post-Development Flow

A	303.53	
B	0.000001	
C	0.69	
T	75.00	mins

Land Use Description	Runoff Coefficient	Intensity (mm/hr)	Area (ha)	Runoff (L/s)
Roof, Parking & Landscape	0.36	15.43	17.97	277.3

$$Q_{\text{Allowable Release}} = \frac{CiA}{0.36}$$

= 277.3 L/s

5-year Post-Development Flow

A	419.91	
B	0.000001	
C	0.691	
T	75.00	mins

Land Use Description	Runoff Coefficient	Intensity (mm/hr)	Area (ha)	Runoff (L/s)
Roof, Parking & Landscape	0.36	21.26	17.97	382.0

$$Q_{\text{Allowable Release}} = \frac{CiA}{0.36}$$

= 382 L/s

10-year Post-Development Flow

A	498.14	
B	0.000001	
C	0.692	
T	75.00	mins

Land Use Description	Runoff Coefficient	Intensity (mm/hr)	Area (ha)	Runoff (L/s)
Roof, Parking & Landscape	0.36	25.11	17.97	451.2

$$Q_{\text{Allowable Release}} = \frac{CiA}{0.36}$$

= 451.2 L/s

25-year Post-Development Flow

A	593.34	
B	0.000001	
C	0.692	
T	75.00	mins

Land Use Description	Runoff Coefficient	Intensity (mm/hr)	Area (ha)	Runoff (L/s)
Roof, Parking & Landscape	0.36	29.91	17.97	537.4

$$Q_{\text{Allowable Release}} = \frac{CiA}{0.36}$$

= 537.4 L/s

50-year Post-Development Flow

A	669.18	
B	0.000001	
C	0.693	
T	75.00	mins

Land Use Description	Runoff Coefficient	Intensity (mm/hr)	Area (ha)	Runoff (L/s)
Roof, Parking & Landscape	0.36	33.58	17.97	603.5

$$Q_{\text{Allowable Release}} = \frac{CiA}{0.36}$$

= 603.5 L/s

100-year Post-Development Flow

A	739.17	
B	0.000001	
C	0.693	
T	75.00	mins

Land Use Description	Runoff Coefficient	Intensity (mm/hr)	Area (ha)	Runoff (L/s)
Roof, Parking & Landscape	0.36	37.10	17.97	666.6

$$Q_{\text{Allowable Release}} = \frac{CiA}{0.36}$$

= 666.6 L/s

Project:	**Whitesands SWA**
Project #:	300030895
Designed By:	O. Feniak
Checked By:	D. Miller
Date:	25-Aug-2014

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Mannings Equation - Trapezoidal Channel

Parameter	Value		units
Flow depth	0.5		m
Side slope Ratio	3	:1	H:V
Bed width	1		m
Top width	4.9		m
Area	1.250		m^2
Wetted Perimeter	4.162		m
Slope	1.42		%
Mannings 'n'	0.1		
Channel Capacity	0.668		m^3/s
Channel Capacity	0.534		m/s

* Don't forget to add Freeboard: 15 cm

Project: **Whitesands SWA**

Location: 300030895
Project #: O. Feniak
Date: D. Miller
Updated: 25-Aug-2014

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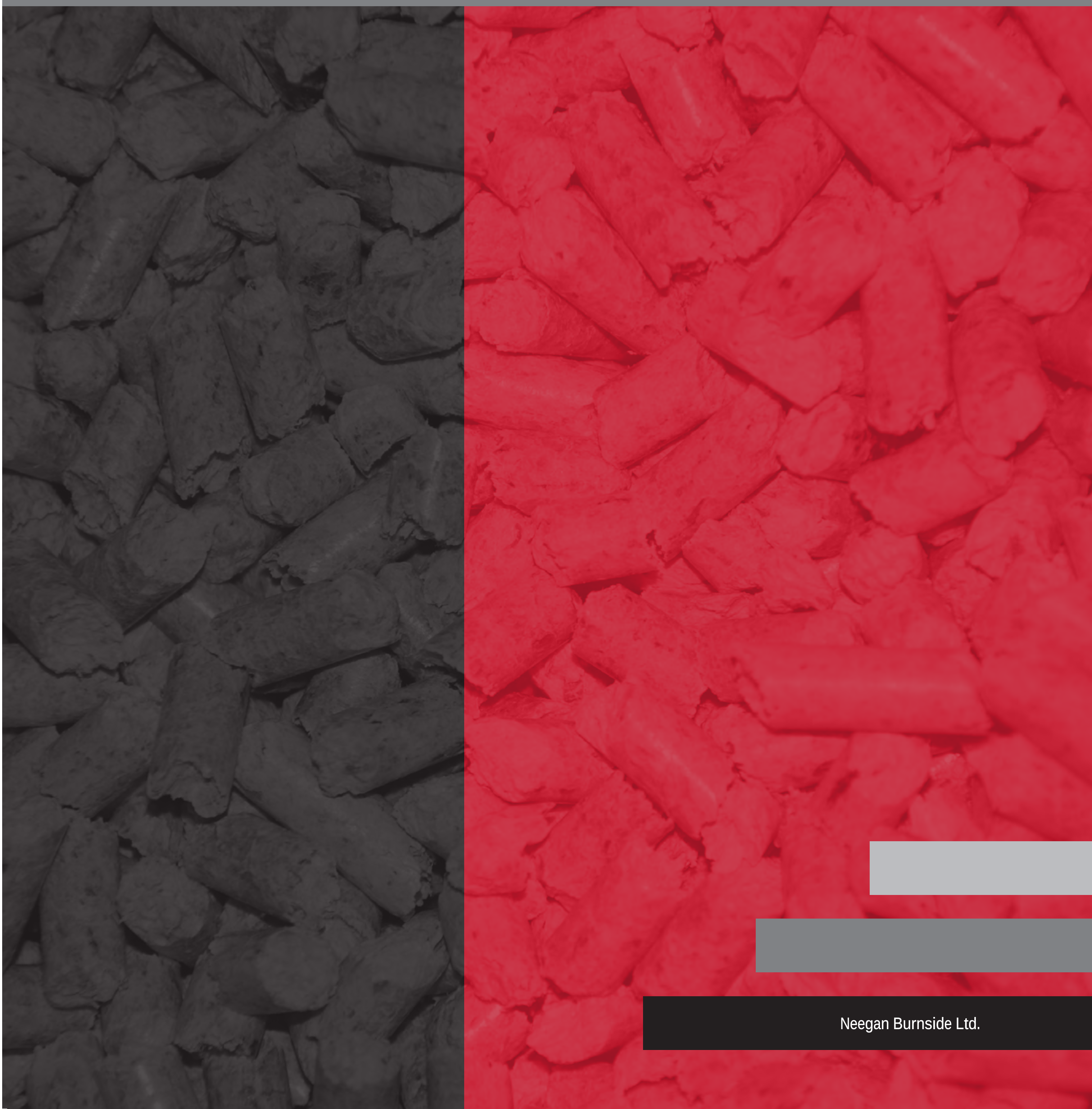
Broad Crested Weir Outlet Structure

Broad Crested Weir Equation

Q=Cd x L x H^1.5
where Cd= 1.35-1.83

Weir Length(L)	9.4
Bed Elev	358.5
Weir Elev	359
Height of Weir Above Bed (Y)	0.5

Elev (m)	H (m)	Cd	Q(m^3/s)
359.01	0.01	1.7	0.02
359.02	0.02	1.7	0.05
359.03	0.03	1.7	0.08
359.04	0.04	1.7	0.13
359.05	0.05	1.7	0.18
359.06	0.06	1.7	0.24
359.07	0.07	1.7	0.30
359.08	0.08	1.7	0.36
359.09	0.09	1.7	0.43
359.1	0.1	1.7	0.51
359.11	0.11	1.7	0.58
359.12	0.12	1.7	0.67
359.13	0.13	1.7	0.75
359.14	0.14	1.7	0.84
359.15	0.15	1.7	0.93
359.16	0.16	1.7	1.03
359.17	0.17	1.7	1.12
359.18	0.18	1.7	1.22
359.19	0.19	1.7	1.33
359.2	0.2	1.7	1.43
359.21	0.21	1.7	1.54
359.22	0.22	1.7	1.65
359.23	0.23	1.7	1.77
359.24	0.24	1.7	1.88
359.25	0.25	1.7	2.00
359.26	0.26	1.7	2.13
359.27	0.27	1.7	2.25
359.28	0.28	1.7	2.37
359.29	0.29	1.7	2.50



Neegan Burnside Ltd.