

Exhibit G

Materials Analysis

Mist Resiliency Project
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Prepared for



NW Natural

Northwest Natural Gas

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Acronyms and Abbreviations

CFM	cubic feet per minute
CY	cubic yard
GPM	gallons per minute
HP	horsepower
HR	hour
HVAC	heating, ventilation, and air conditioning
KO	knock out
KVA	1,000 volt-amps
KW	kilowatt
LBS	pounds
LF	linear foot
MBTU	one thousand British thermal units
MMSCFD	million standard cubic feet per day
NMCS	North Mist Compressor Station
NWN	Northwest Natural Gas
OAR	Oregon Administrative Rules
OSFM	Oregon State Fire Marshall
PH	phase
Project	Mist Resiliency Project
RCRA	Resource Conservation and Recovery Act
S/S	seam to seam
SCFM	standard cubic feet per minute
SDS	safety data sheets

1.0 Introduction

Northwest Natural Gas (NWN), the Certificate Holder, proposes to amend the Site Certificate for its underground natural gas storage facility at the Mist Resiliency Project (Project) in Columbia County, Oregon. Exhibit G provides an analysis of materials for the Project, as required to meet the submittal requirements of Oregon Administrative Rule (OAR) 345-021-0010(1)(g) paragraphs (A) through (C). OAR 345 Division 22 does not provide an approval standard specific to Exhibit G.

2.0 Materials Inventory – OAR 345-021-0010(1)(g)(A)

OAR 345-021-0010(1)(g) A materials analysis including:

OAR 345-021-0010(1)(g)(A) An inventory of substantial quantities of industrial materials flowing into and out of the proposed facility during construction and operation;

2.1 Construction Materials

Construction at the North Mist Compressor Station (NMCS) will include land clearing, grading, and shallow foundations for a new compressor station that will be installed next to the existing plant (North Mist -1). This includes the installation of three new Ariel KBC/4 compressors driven by three CAT 3608 A/4 engines, two TEG Dehy Contactors, two glycol regen skids with reboilers , two inlet filter coalescers and two outlet filter coalescers, two new 750KW generators, one blowdown silencer, one air system consisting of two compressors, dryers, prefilters, and wet air receiver, one skidded compressor fuel gas heater, one skidded fuel gas regulators system, two lube oil tanks, one water maze, one 1500KVA 3PH transformer, one PDC building. There are four Metal Building Systems associated with the project including one office/control building, one compressor building, one regen building, one oily water evaporator and one portable water tank for the office building. See Table G-1 for an inventory of major equipment and materials for the NMCS.

Table G-1. Inventory of Facility Major Equipment & Materials – NMCS

Equipment	Description	Units	Quantity
Metal Building System	Compressor building 130' x 55'	Each	1
Metal Building System	Regen building 70' x 70'	Each	1
Metal Building System	Office Building 100' X 62'	Each	1
Inlet Filter Coalescers	110 MMscfd Capacity 36" OD x 10'0" S/S	Each	2
Dehy-regen skid: Glycol contactor Glycol air cooler Glycol/gas exchanger	110 MMscfd capacity (60" OD, 36' S/S)	Each	2

Equipment	Description	Units	Quantity
Reciprocating Compressor	CAT G3608 /A4 - Ariel KBC/4 2,750 ISO HP	Each	3
Compressor Fuel Gas Heater	770 MBTU/hour 21' L x 7'8" W x 14'3"H	Each	1
Blowdown Silencer	Stack: 4 FT OD X 15 Feet	Each	1
Instrument Air Package: Instrument Air Compressor	Compressor 475 SCFM	Each	2
Engine Lube oil make up tank	3000 Gallons tank (6' OD x 18' L)	Each	1
Cylinder Lube oil make up tank	3000 Gallons tank (6' OD x 18' L)	Each	1
Outlet Filter Coalescers	28" OD x 10'-0" S/S	Each	2
Transformer	1500KVA, 3PH, 12.47KV/480V	Each	1
Generator	750KW, 480V, 3PH	Each	2
Power Distribution Center (PDC)	With HVAC, lighting, power distribution panels, fire and smoke detection	Each	1
Bridge crane [@compressor Bldg]	10 tons	Each	1
Jib crane (@Regen Bldg)	¼ ton, 11' HUB, 11' span	Each	2
Oily Water Evaporator	100" L X 48" W X 52" H	Each	1
Gasoline Tank	2000 Gallons	Each	1
Diesel Tank	100 Gallons	Each	1
Medium Voltage Transformers	45kVA, 480V-4160V	Each	3

Construction at Miller Station will include removal of the existing turbines (units GC-500 and GC-600), and their associated oil coolers, gas coolers, gas scrubbers, piping and valves, intake filters, exhaust silencers, fuel gas filter, regulation and measurement equipment and electrical distribution and control panels. The construction will also include the installation of foundations for the replacement turbine/compressor packages, an 8-foot extension to the existing compressor building, and installation of associated oil coolers, gas coolers, gas scrubbers, piping and valves, intake filters, exhaust silencers and electrical distribution and control panels. A new fuel gas skid for the replacement turbines will be installed west of the compressor building. See Table G-2 for an inventory of major equipment and materials for Miller Station.

Table G-2. Inventory of Facility Major Equipment & Materials - Miller Station

Equipment	Description	Units	Quantity
Metal Building System	Addition to the existing compressor building 70' x 8'	Each	1
Inlet Gas Scrubber	3' x 12'	Each	2
Gas Cooler	14' x 40'	Each	2
Gas Turbine/Compressor Skid	8'-6" x 45'	Each	2

Equipment	Description	Units	Quantity
Gas Turbine Lube Oil Cooler	6'-6" x 12	Each	2
Gas Turbine Exhaust Silencer and Duct	Typical Solar 60 Exhaust System (From Solar Turbines)	Each	2
Gas Turbine Air Intake Silencer and Duct	Typical Solar 60 Air Intake - Elevated (From Solar Turbines)	Each	2
Electrical Power Distribution and Control Panels	The electrical equipment, Control panels and other equipment will be installed in an existing building that will be refurbished to accommodate this equipment.	Lot	1
Gas Turbine Fuel Gas Regulation Skid	Will consist of a heater and regulators. This system will feed both gas turbines.	Each	1

Typical materials needed for construction of the Project include rock and gravel aggregate, water, concrete, structural steel, carbon steel piping, and assorted electrical equipment and materials, as well as smaller quantities of other materials such as fuels and oils. Rock and aggregate materials will be needed for existing access road improvements, and for other permanent and temporary gravel-surfaced areas. Aggregate suppliers in the vicinity of the Project will be determined by the construction contractor. See Tables G-3 and G-4 for an inventory of construction materials at NMCS and Miller Station, respectively.

Table G-3. Inventory of Construction Materials – NMCS

Material	Purpose	Ultimate Disposition	Units	Quantity
Excavation (24" Top Soil Stripping)	Remove Top Soil and stockpile	Will be replaced on grading area	CY	23,000
Excavation (Cut)	Remove Dirt	Will be placed in different location on site	CY	75,000
Embankment (Fill)	Place Dirt	Final location of dirt	CY	70,000
Excess Soil Export	Remove excess dirt from site	Removed from site	CY	5,000
Clearing and Grubbing	Remove unsuitable materials from site	Materials removed from site	Acre	9.0
Aggregate Surfacing	Top 6" of rock placed across the entire site	Permanent surface rock across entire site	CY	2,100
Aggregate Base Course	Base course under the rock surfacing, 12" under the compressor station pad and 24" under the roads.	Permanent base across entire site	CY	2,650
Revegetation (Seeding)	Revegetation of areas disturbed during construction	Revegetation	Acre	9.0

Material	Purpose	Ultimate Disposition	Units	Quantity
Straw Waddles	Erosion control to prevent soil erosion and water runoff	Removed from site after facility startup	LF	350
Silt Fence	Erosion control to prevent solids from being washed downslope from the area of disturbance	Removed from site after facility startup	LF	1,300
Concrete Washout Area	Confines contaminated water and slurry from concrete operations, preventing it from leaving the construction site.	Removed from site after facility startup	LS	1
Stabilize Staging Area (Storage Area)	Area for storage of materials	Removed from site after facility startup	SF	40,000
Vehicle Tracking Pad	Prevents vehicles tracking soil and mud offsite, and stabilizes construction entrance	Removed from site after facility startup	SF	1,500
Remove Vehicle Tracking Pad	Prevents vehicles tracking soil and mud offsite, and stabilizes construction entrance	Removed from site after facility startup	SF	1,500
Temporary Sedimentation Basin	Removal of suspended sediment from water generated during construction	Removed from site after facility startup	Each	1
Erosion Control Blankets	Protection of bare soil from runoff erosion	Remain in place as they protect bare soil and promote vegetation growth	SY	34,800
Subgrade Preparation (Scarify/Recompact)	Preparation of the subgrade	This will be what the facility is constructed on	SY	47,200
Finish Grade	Final Grading Operations	Removed from site after facility startup	SY	47,200
Erosion Control - General and Maintenance	Maintenance Required to keep erosion control measures working properly	Removed from site after facility startup	Lot	1
Removal of Erosion Control - General and Maintenance	Removal of erosion control	Removed from site after facility startup	Lot	1
Water Truck for Dust Mitigation	Dust Control	Removed from site	Lot	1
Removal of Expanded Metal Fence	Fence Removal to allow for new site grading	Removed from site	LF	1,233

Material	Purpose	Ultimate Disposition	Units	Quantity
Expanded Metal Fence	Fence Replacement after site grading is completed	Fence to Remain	LF	1,400
24" RCP	Pipe to drain the site	Permanent drainage feature	LF	120
Cast in Place (CIP) concrete	Foundations for compressors, coolers, generators, filter coalescers, TEG Dehy	Permanent Equipment Foundations	CY	747
Rebar	Tension reinforcing	Permanent Equipment Foundations	LBS	112,885
Anchor Bolts	Anchors equipment to concrete	Permanent Equipment Foundations	Each	556
Column, Beam, and Mat Edge forms	Concrete formwork	Temporary – removed once concrete sets	SF	5,526
Grout	Non shrink grout for elevation purposes	Permanent Equipment Foundations	SF	2,107
Concrete (Deep Foundations)	Drilled Shaft Foundations – equipment support	Permanent deep foundation	CY	633
Epoxy Grout	Under Compressor for dynamic equipment	Permanent Equipment Foundations	CY	10.6
Structural Steel	Access platforms, pipe supports, tray supports, access stairs, walkover stile	Permanent access structures and supports	Tons	38.6
Concrete (buildings)	Frost wall, slab on grade, concrete deck, footings, pedestals, footings, wall	Office, regen, compressor, and warehouse building	CY	1,041
Structural Steel	Columns, Floor framing, roof framing	Office Building	Tons	87.1
Structural Steel	Columns, Floor framing, roof framing	Regen Building	Tons	26.2
Structural Steel	Columns, Floor framing, roof framing	Compressor Building	Tons	54.7
Structural Steel	Columns, Floor framing, roof framing	Warehouse Building	Tons	11.6
Copper clad steel grounding rods	Dissipate energy to prevent shorts	Permanent grounding system	LF	620
Grease	Lubrication of equipment, specific to components that rotate	Unused grease will be recycled or disposed of as hazardous waste per Oregon Administrative Rules Chapter 340 Division 111	Gallons	10

Material	Purpose	Ultimate Disposition	Units	Quantity
Heavy, medium, and light lubricant oils	Equipment lubrication	Unused oil will be recycled or disposed of as hazardous waste per Oregon Administrative Rules Chapter 340 Division 111	Gallons	10
Non-petroleum-based solvents	Cleaning of equipment	Unused oil will be recycled if possible or disposed at appropriate facility	Gallons	10

Table G-4. Inventory of Construction Materials – Miller Station

Material	Purpose	Ultimate Disposition	Units	Quantity
Aggregate Surfacing	Top 6" of rock placed across the entire site	Permanent surface rock across entire site	CY	700
Aggregate Base Course	Base course under the rock surfacing, 12" under the compressor station pad and 24" under the roads.	Permanent base across entire site	CY	1,400
Geotextile Fabric	Soil reinforcement along driveways	Remains onsite beneath driveways	SY	1,900
Seeding	Revegetation of areas disturbed during construction	Revegetation	Acre	0 (no soil disturbance is planned outside graveled areas)
Straw Wattles	Erosion control to prevent soil erosion and water runoff	Removed from site after facility startup	LF	600
Silt Fence	Erosion control to prevent solids from being washed downslope from the area of disturbance	Removed from site after facility startup	LF	600
Concrete Washout area	Confines contaminated water and slurry from concrete operations, preventing it from leaving the construction site.	Removed from site after facility startup	Each	1
Vehicle tracking pad	Prevents vehicles tracking soil and mud offsite, and stabilizes construction entrance	Removed from site after facility startup	SF	1,500

Material	Purpose	Ultimate Disposition	Units	Quantity
Temporary sedimentation basin	Removal of suspended sediment from water generated during construction	Removed from site after facility startup	Each	1
Cast in Place (CIP) concrete	Foundations for compressor building addition, turbine/compressor skids, inlet air filters, exhaust silencers, oil coolers, pipe supports, and fuel gas skid.	Permanent Equipment Foundations	CY	310
Rebar	Tension reinforcing	Permanent Equipment Foundations	LBS	46,500
Anchor Bolts	Anchors equipment to concrete	Permanent Equipment Foundations	Each	300
Column, Beam, and Mat Edge forms	Concrete formwork	Temporary – removed once concrete sets	SF	1,800
Grout	Non shrink grout for elevation purposes	Permanent Equipment Foundations	SF	700
Epoxy Grout	Under compressor for dynamic equipment	Permanent Equipment Foundations	CY	1
Structural Steel	Access platforms, pipe supports, tray supports, access stairs, walkover stile	Permanent access structures and supports	Tons	TBD
Structural Steel	Columns, Wall framing, roof framing	Compressor Building	Tons	TBD
Structural Steel	Columns, Floor framing, roof framing	Equipment Building	Tons	TBD
Copper clad steel grounding rods	Dissipate energy to prevent shorts	Permanent grounding system	LF	620
Grease	Lubrication of equipment, specific to components that rotate	Unused grease will be recycled or disposed of as hazardous waste per Oregon Administrative Rules Chapter 340 Division 111	Gallons	10
Heavy, medium, and light lubricant oils	Equipment lubrication	Unused oil will be recycled or disposed of as hazardous waste per Oregon Administrative Rules Chapter 340 Division 111	Gallons	10

Material	Purpose	Ultimate Disposition	Units	Quantity
Non-petroleum-based solvents	Cleaning of equipment	Unused oil will be recycled if possible or disposed at appropriate facility	Gallons	10

Large equipment, such as cranes, excavators, dump trucks, weld trucks, tractor/trailer rigs, compactors, and dozers will be utilized during construction. In addition, large facility equipment and materials will be hauled to the construction areas by tractor/trailer rigs and either offloaded into designated staging areas, or directly placed on the pad.

During construction, temporary trailers and storage facilities will be required and most materials that are not in use will be stored in temporary staging areas. Industrial materials flowing into the Project include fuels and lubricants associated with construction equipment. These materials will be stored in the temporary staging areas as well. Oils, lubricants, and solvents will be stored within covered containers such as work trailers and Conex boxes to prevent incidental spills or drips from reaching the environment. Fuels will be stored in mobile, double walled tanks, or proper designated locations with spill protection, to be located within the construction staging area. The primary location for fueling will occur offsite at local gas stations, and the mobile tanks will only be used to fuel equipment that cannot travel off-site (such as excavators). On-site refueling will occur only within the staging areas and utilize proper spill protection accordingly.

Post-construction, during operation of the Project, the only equipment that will be present is pickup-sized vehicles that will be used for operation and maintenance purposes by the operations team.

NWN utilizes a hazardous and nonhazardous waste reduction and recycling program for all of its facilities. Recycling and reuse are a priority for NWN and will be administered during the construction phase and during the day-by-day operations of the Project (see Section 4).

2.2 Operational Materials

No substantial quantities of industrial materials will be stored on the Project during operation. Lubricating oils and antifreeze will be present at the Project and will be fully contained within the compressors. Lubricating oils and antifreeze are drained and replaced periodically. New oil will be brought in on an as-needed basis and used oil will be stored in the waste oil tank waiting removal for recycling by a licensed vendor.

If heavy equipment is necessary for major maintenance or overhauls, such as the replacement of a compressor, it is assumed its use will be similar to the construction stage. Fuel or oils needed for maintenance will be delivered by a licensed maintenance contractor on an as-needed basis, and no substantial quantities will be stored on-site.

Major equipment may need to be replaced during the lifetime of the Project; however, due to the unpredictable nature of major maintenance problems, no estimate has been provided for the

amount of major components that may be needed. Minor maintenance may also require the replacement and removal of smaller components, which are not expected to constitute substantial amounts of industrial materials. Minor and potentially hazardous materials could include oily rags or similar materials related to equipment lubrication and other maintenance.

Small quantities of lubricating oils, cleaners, or antifreeze may be stored at the Project for operations use. None would be present in substantial reportable quantities; the amounts present (if any) would be no greater than household quantities.

Table G-5 provides a list of materials estimated for use for a typical 5-year operation period. Operations materials are variable, and dependent upon the maintenance or repair events that occur. It is possible that no materials would be required during a typical 5-year period; however, Table G-5 provides for minimal replacement of materials that are sometimes lost, damaged, or stolen. Operations materials would be delivered to the required location at the time needed.

Table G-5. Materials Inventory for Operations (Typical 5-Year Estimate)

Material	On-Site Storage	Quantity
Tri-ethylene glycol (TEG) (dehydration fluid)	Fresh TEG is brought in as needed for change out with used TEG being removed for recycling.	Anticipated replacement every three to ten years depending on operating conditions. Dehydration units hold 2500 gallons each (2 units).
Oils (compressor and engine lubricants, gear oil and transformer coolant)	Small quantity stored in buildings for minor maintenance. Full oil change performed as needed by a specialized contractor or appropriately trained company personnel and used oils removed for recycling.	Estimated at up to 400 gallons per year, dependent on maintenance schedule.
Ethylene glycol (anti-freeze)	Small quantity stored in buildings for minor maintenance.	Estimated at up to 250 gallons every four years per anticipated maintenance schedule.
WD-40; grease (general lubricant)	Small quantity stored in buildings for minor maintenance.	Estimated at up to 1 gallon per year, dependent on need.
Simple Green (general cleaner)	Small quantity stored in buildings for minor maintenance.	Estimated at up to 5 gallons per year, dependent on need.
Charcoal Filters	Small quantity stored in buildings for routine changes.	Anticipated replacement of 4 filters every year depending on operating conditions.
Glycol Sock Filters	Small quantity stored in buildings for routine changes.	Anticipated replacement of 8 filters every year depending on operating conditions.
Coalescing Filters	Small quantity stored in buildings for routine changes.	Anticipated replacement of 76 filters every two years depending on operating conditions.

3.0 Hazardous Materials Handling and Management – OAR 345-021-0010(1)(g)(B)

OAR 345-021-0010(1)(g)(B) The applicant's plans to manage hazardous substances during construction and operation, including measures to prevent and contain spills; and

During both the construction and operational phases of the Project, it may be necessary to use minor quantities of hazardous substances (materials requiring Safety Data Sheets [SDS]). These materials would include small, but necessary, quantities of fuels, lubricants, oils, greases, antifreeze, tri-ethylene glycol, and hydraulic fluids. All potentially hazardous substances, during both phases, will be used in a manner that is protective of human health, protective of the environment, and that complies with all applicable local, state, and federal environmental laws and regulations. For any necessary potentially hazardous substance used during either the construction or operational phase, SDSes will be made available and located at the construction area or the Project.

Extremely Hazardous Substances in excess of Threshold Planning Quantities, highly toxic materials, or explosive materials will not be necessary to support either the construction or the operational phase. Additionally, materials used during the construction and operation of the Project will be selected such that they minimize the potential for producing “hazardous waste” as defined by the Resource Conservation and Recovery Act (RCRA).

3.1 Construction Materials

Potentially hazardous substances used during the construction phase may include gasoline, diesel, hydraulic oil, lubricants, paints, and pipe coating. It is anticipated that only minor quantities of potentially hazardous substances will be necessary to complete construction, and it will only be present in quantities similar to household levels.

No potentially hazardous substances will be permanently present within the construction yards at quantities that exceed Oregon State Fire Marshall (OSFM) Reportable Quantities. When not in use, all potentially hazardous substances will be stored in a covered and lockable location with appropriate secondary containment that is staged within a designated area.

Fuel for construction equipment will be delivered to the site via a specialized mobile vehicle by a licensed service contractor on an as-needed basis. Following the completion of fueling activities, these vehicles will leave the site. Fueling for smaller mobile vehicles will be completed off site at nearby privately owned fueling stations.

Construction equipment will be regularly inspected for potential leaks or other issues that may require maintenance. Potentially hazardous substances related to the maintenance of the construction equipment will be brought to the construction site on an as-needed basis, and any unused or waste substances will be removed during the same service call.

The prevention and minimization of accidental releases of these materials will be accomplished through proper containment during use and transportation to the Project site, and the observance

of appropriate handling procedures during the transferring of fuels from the delivery vehicles to the construction equipment. All fueling and vehicle maintenance operations will be performed a sufficient distance, at least 100 feet, from any sensitive ecosystems (e.g., riparian, wetland, potential nesting areas) to avoid potential impacts. In the unlikely event that an accidental spill occurs, the spilled or released substances will be cleaned up, and contaminated media impacted by the spill will be managed in accordance with applicable regulations. Spill kits with absorbents, absorbent pads, spill socks, and disposable bags will be maintained at the construction yard in close proximity to construction activities. In addition, to reduce the response time to a spill, smaller spill kits containing absorbent pads will be located on key pieces of construction equipment. All workers will be instructed regarding the location, handling, and usage of the spill kits. All spills will be reported to a designated, qualified person who will assess cleanup activities and determine if further actions or notifications are required.

3.2 Operations Materials

Potentially hazardous substances used during the operational phase of the Project may include lubricating oils, dehydration fluid, and antifreeze. The operation of the Project will produce small amounts of compressor crankcase oil, occasional oil-contaminated tri-ethylene glycol, oil/water separator oils, oily rags, and oil filters. In accordance with NWN's existing recycling program, the crankcase oil, tri-ethylene glycol and oil/water separator oils will be collected, transported and recycled by a third party (a specialized company in waste management). Oily rags and oil filters will be disposed of by a permitted facility.

It is anticipated that the types, amounts, and usage of potentially hazardous substances will be limited based on the operational nature of the Project and the limited need for these substances. Any potentially hazardous substances necessary to support the long-term operation of the Project will either be limited to quantities of less than OSFM Reportable Quantities, or disclosed annually as part of the Community Right to Know Act managed by the OSFM. When such substances are not in use, they will be either stored in a secure building or stored in appropriate structures specifically designed for the substance, which will meet all applicable regulatory requirements. Substances will be selected in such a manner to minimize the potential for producing RCRA defined hazardous wastes. Table G-5 provides an inventory of industrial materials that would be used during operation of the Project.

In the unlikely event that an accidental spill occurs during the operational phase at the Project, the spilled or released substances will be cleaned up and contaminated media will be managed in accordance with all applicable RCRA regulations. Spill kits with absorbents, absorbent pads, spill socks, and disposable bags will be located within the Project and in close proximity to structures which may contain potentially hazardous substances. All employees associated with the operation of the Project will be trained regarding the location and usage of the spill kits, and an emergency contact list will be maintained at the Project.

4.0 Non-Hazardous Waste Management – OAR 345-021-0010(1)(g)(C)

OAR 345-021-0010(1)(g)(C) The applicant's plans to manage non-hazardous waste materials during construction and operation.

NWN will fully comply with all applicable waste handling and disposal regulations on all lands associated with the Project, during both construction and operation. Solid waste will be stored in a manner that does not constitute a fire, health, or safety hazard until such time as it can be hauled offsite for recycling or disposal, as appropriate.

4.1 Construction Phase

Construction wastes will consist of non-hazardous equipment packaging and general construction debris. The material will consist of concrete, fiber board, wood, plastic, conduit, scrap wire and scrap steel, welding rod, and erosion control materials:

- Steel scraps and copper wiring scraps will be separated and recycled to the extent feasible.
- Wood from concrete forms will be reused when possible and then recycled.
- Excess excavated material will be used to restore ground contours after construction.
- Erosion control materials such as silt fencing and bio-bags will be transported to a local landfill.

The waste materials will be transported to an appropriate recycling facility, utilizing NWN's established recycling program, or to a nearby landfill for non-recyclable goods. Exhibit W contains a detailed description of the Project's waste management aspects.

4.2 Operational Phase

During operations, little to no solid waste will be generated at the Project.